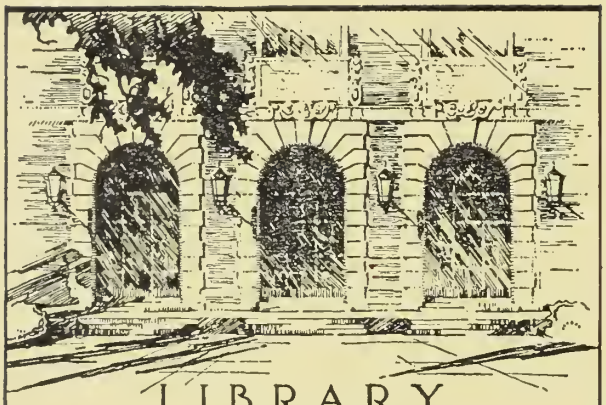

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IVERSITY OF ILLINOIS GRADUATE COLLEGE

UNIVERSITY OF ILLINOIS BULLETIN

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UNIVERSITY OF ILLINOIS GRADUATE COLLEGE

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1964-1965

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Earl Reece Leng, Ph.D., Professor of Plant Breeding and of Genetics

Milan Vaclav Novak, Ph.D., M.D., D.Sc., Associate Dean of the Graduate College at the Medical Center, Chicago; Professor of Microbiology and Head of the Department of Microbiology

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Herbert Stern, Ph.D., Professor of Botany

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Communications	Theodore Peterson
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French	Charles Anthony Knudson

* Awards master's degree only.

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Geography	Joseph Albert Russell
Geology	George Willard White
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Library Science	Herbert Goldhor
Life Sciences	Ralph E. Kallio
Linguistics	Robert B. Lees
Marketing	Daniel Michael Slate
Mathematics	Paul Trevier Bateman
Mechanical and Industrial Engineering	Helmut Hans Korst
Microbiology	L. Leon Campbell
Mining, Metallurgy, and Petroleum Engineering	Thomas Albert Read
Music	Duane Adams Branigan
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Political Science	Charles Banner Hagan
Psychology	Lloyd G. Humphreys
*Radio and Television	Hubert Victor Cordier
*Recreation and Municipal Park Administration	Charles K. Brightbill

* Awards master's degree only.
† Awards master's degree in Management only.

Slavic Languages and Literatures	Lew R. Micklesen
*Social Work	Mark Pendleton Hale
Sociology	Daniel Glaser
Spanish, Italian, and Portuguese	William Hutchinson Shoemaker
Speech and Theatre	Karl Richards Wallace
Theoretical and Applied Mechanics	Thomas James Dolan
*Urban Planning and Landscape Architecture	Louis Bemis Wetmore
Veterinary Medical Science	Carl Alfred Brandly
Zoology	Paul Hyman Silverman

* Awards master's degree only.

Calendar of the Graduate College

SUMMER SESSION, 1965

June 21, Monday.....Registration of graduate students not enrolled in the second semester, 1964-65. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 15.)

June 22, Tuesday.....Instruction begins.

June 22, Tues.–
June 23, Wed.....Registration of graduate students enrolled in the second semester, 1964-65. (Authorization cards distributed on alphabetical basis.)

July 2, Friday.....Applications to take French examination on July 16 will not be accepted in Graduate College Office after this date.

July 4, Sunday.....Independence Day.

July 5, Monday.....Independence Day holiday.

July 9, Friday.....Applications to take German examination on July 23 will not be accepted in Graduate College Office after this date.

July 16, Friday.....Applications to take Russian examination on July 30 will not be accepted in Graduate College Office after this date.

July 16, Friday evening.....French examination.

July 23, Friday evening.....German examination.

July 26, Monday.....Last day for dropping a course without grade of E.

July 30, Friday evening.....Russian examination.

August 13, Friday.....No names will be added to the August graduation list after this date.

Aug. 13, Fri.–Aug. 14, Sat.....Summer session examinations.

August 16, Monday.....Last day for candidates for the master's degree in August to deposit theses.

September 10, Friday.....Last day for candidates for the doctoral degree in October to submit theses and abstracts to Graduate College Office for approval of format.

September 24, Friday.....Last day to file application for the master's degree in October.

September 24, Friday.....Last day for candidates for the master's degree in October to deposit theses.

September 25, Saturday.....Last day for finals for the doctoral degree in October.

October 1, Friday.....Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

FIRST SEMESTER, 1965-1966

August 3, Tuesday.....Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1965.

August 31, Tuesday.....Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1965.

Sept. 15, Wed.–Sept. 18, Sat. to noon.....Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, September 18. There will be no registration on Saturday, September 25.)

September 18, Saturday.....Last day for registration without payment of late registration fine.

September 20, Monday.....Instruction begins.

October 1, Friday.....Applications to take French examination on October 15 will not be accepted in Graduate College Office after this date.

October 8, Friday.....Applications to take German examination on October 22 will not be accepted in Graduate College Office after this date.

October 15, Friday.....Applications to take Russian examination on October 29 will not be accepted in Graduate College Office after this date.

October 15, Friday evening.....French examination.

October 22, Friday evening.....German examination.

October 29, Friday evening.....Russian examination.

November 1, Monday.....Last day for adding a course to program.

November 12, Friday.....Applications to take French examination on December 3 will not be accepted in Graduate College Office after this date.

November 19, Friday.....Applications to take German examination on December 10 will not be accepted in Graduate College Office after this date.

November 20, Saturday.....Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

November 24, Wednesday, 1 P.M..Thanksgiving vacation begins.

November 29, Monday, 1 P.M...Thanksgiving vacation ends.

December 3, Friday.....Applications to take Russian examination on December 17 will not be accepted in Graduate College Office after this date.

December 3, Friday evening.....French examination.

December 10, Friday evening....German examination.

December 13, Monday.....Last day for dropping a course without grade of E.

December 17, Friday evening....Russian examination.

December 22, Wednesday, 1 P.M...Christmas vacation begins.

1966

January 3, Monday, 1 P.M.....Christmas vacation ends.

January 14, Friday.....Last day for candidates for the doctoral degree in February to submit theses and abstracts to Graduate College Office for approval of format.

Jan. 17, Mon.–Jan. 25, Tues.....Semester examinations.

January 21, Friday.....No names will be added to the February graduation list after this date.

January 24, Monday.....Last day for candidates for the master's degree in February to deposit theses.

January 29, Saturday.....Last day for finals for the doctoral degree in February.

February 1, Tuesday.....Last day for candidates for the doctoral degree in February to deposit theses and abstracts.

SECOND SEMESTER, 1965-1966

Feb. 2, Wed.–Feb. 5, Sat. to noon..Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, February 5. There will be no registration on Saturday, February 12.)

February 5, Saturday.....Last day for registration without payment of late registration fine.

February 7, Monday.....Instruction begins.

February 14, Monday.....Last day for application for fellowships for 1966-67.

February 18, Friday.....Applications to take French examination on March 4 will not be accepted in Graduate College Office after this date.

February 25, Friday .....Applications to take German examination on March 11 will not be accepted in Graduate College Office after this date.

March 4, Friday.....Applications to take Russian examination on March 18 will not be accepted in Graduate College Office after this date.

March 4, Friday evening.....French examination.

March 11, Friday evening.....German examination.

March 18, Friday evening.....Russian examination.

March 21, Monday.....Last day for adding a course to program.

April 2, Saturday.....Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

April 8, Friday.....Applications to take French examination on April 29 will not be accepted in Graduate College Office after this date.

April 9, Saturday, noon.....Spring vacation begins.

April 18, Monday, 1 P.M.....Spring vacation ends.

April 25, Monday.....Applications to take German examination on May 6 will not be accepted in Graduate College Office after this date.

April 25, Monday.....Last day for dropping a course without grade of E.

April 29, Friday.....Applications to take Russian examination on May 13 will not be accepted in Graduate College Office after this date.

April 29, Friday.....No names will be added to the June graduation list after this date.

April 29, Friday.....Honors Day. Classes dismissed at noon.

April 29, Friday evening.....French examination.

May 6, Friday evening.....German examination.

May 13, Friday evening.....Russian examination.

May 20, Friday.....Last day for candidates for the doctoral degree in June to submit theses and abstracts to Graduate College Office for approval of format.

May 27, Friday.....Last day for candidates for the master's degree in June to deposit theses.

May 30, Monday.....Memorial Day (holiday).
May 31, Tues.–June 8, Wed.....Semester examinations.
June 3, Friday.....Last day for finals for the doctoral degree in June.
June 8, Wednesday.....Last day for candidates for the doctoral degree in June to deposit theses and abstracts.
June 18, Saturday.....Commencement exercises.

SUMMER SESSION, 1966

June 20, Monday.....Registration of graduate students not enrolled in the second semester, 1965-66. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 15.)
June 21, Tuesday.....Instruction begins.
June 21, Tues.–June 22, Wed....Registration of graduate students enrolled in the second semester, 1965-66. (Authorization cards distributed on alphabetical basis.)
July 1, Friday.....Applications to take French examination on July 15 will not be accepted in Graduate College Office after this date.
July 4, Monday.....Independence Day (holiday).
July 8, Friday.....Applications to take German examination on July 22 will not be accepted in Graduate College Office after this date.
July 15, Friday.....Applications to take Russian examination on July 29 will not be accepted in Graduate College Office after this date.
July 15, Friday evening.....French examination.
July 22, Friday evening.....German examination.
July 25, Monday.....Last day for dropping a course without grade of E.
July 29, Friday evening.....Russian examination.
August 12, Friday.....No names will be added to the August graduation list after this date.
Aug. 12, Fri.–Aug. 13, Sat.....Summer session examinations.
August 15, Monday.....Last day for candidates for the master's degree in August to deposit theses.
September 9, Friday.....Last day for candidates for the doctoral degree in October to submit theses and abstracts to Graduate College Office for approval of format.
September 23, Friday.....Last day to file application for the master's degree in October.

September 23, Friday.....Last day for candidates for the master's degree in October to deposit theses.

September 24, Saturday.....Last day for finals for the doctoral degree in October.

September 30, Friday.....Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

DEADLINE DATES FOR SUBMITTING APPLICATIONS FOR ADMISSION OR READMISSION IN SEPTEMBER, 1966

August 3, Wednesday.....Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1966.

August 31, Wednesday.....Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1966.

THE GRADUATE COLLEGE

A land-grant institution, the University of Illinois has its main campus at Urbana-Champaign, a community of 86,000 located 128 miles south of Chicago. Total enrollment in the various branches of the University—the Graduate College and undergraduate colleges at Urbana, the graduate and professional colleges at the Medical Center, Chicago, and the undergraduate colleges at Chicago Circle—exceeded 39,000 in 1964-1965. The combined faculty and staff included the full-time equivalent of more than 12,700 members.

The Graduate College of the University of Illinois at Urbana offers instruction leading to advanced degrees in over one hundred fields of learning. Graduate enrollment currently exceeds 7,000 students who represent every state and seventy foreign countries. Today, a graduate faculty of 1,200 implements the University of Illinois Statutes which charge the Graduate College with the responsibility "to safeguard and promote standards of graduate work on the Urbana-Champaign campus and at the Medical Center, Chicago, and to promote and assist in the development of research in all fields."

Graduate work in the medical and dental sciences and in pharmacy is offered in Chicago at the University's Medical Center. Inquiries concerning these programs should be directed to Dr. Milan V. Novak, Associate Dean of the Graduate College, University of Illinois at the Medical Center, 1853 West Polk Street, Chicago (P.O. Box 6998, Chicago 60680).

Graduate instruction offered at the Urbana campus is listed by areas on pages 3 to 5 and is described in detail within the departmental listings, arranged alphabetically in this catalog.

The general requirements for admission and the degree requirements established by the Graduate College are described in this introductory section. All candidates for degrees must meet these requirements as well as those specified by the major departments within the departmental listings. Every graduate student should have a Graduate College catalog and, if available, a departmental bulletin. The Graduate College calendar included in this catalog is also printed separately and may be obtained from the Graduate College Office, 330 Administration Building.

Admission

It is recommended that prospective students apply for admission about two months before the beginning of the term in which they expect to enroll. Applications for admission or readmission, including all necessary credentials, *must be submitted* by domestic students at least two weeks prior to registration or by foreign students at least six weeks prior to registration.

A nonrefundable deposit of $30.00 on tuition and fees is required of all *new and readmitted domestic graduate students.* This deposit should not be sent until requested by the University. Graduate students assured of the award of a fellowship, assistantship, or tuition and fee waiver are permitted to confirm their intention to enroll without payment of the advance deposit.

Admission forms may be obtained from the Office of Admissions and Records, 176 Administration Building, or from the Graduate College. Foreign students should request admission by letter (see page 19).

An applicant will be favorably considered for admission to the Graduate College if: (1) he is a graduate of an institution awarding a baccalaureate degree comparable to that granted by the University of Illinois; (2) he is adequately prepared for advanced study as demonstrated by his previous program of study and his scholastic record; and (3) he is recommended for admission by his major department and the Dean of the Graduate College.

The prerequisites for advanced work in the various fields of specialization are listed in the departmental sections of this catalog. Also listed are the scholastic grade-point averages which must be met before an application for admission is considered. The scholastic average is computed on the basis of the last sixty semester hours of work completed. Applicants with an average less than 3.5 are advised not to apply. (In a four-passing grade system, A = 5.0; B = 4.0; etc.)

A department's recommendation with respect to the admission of an applicant is not based solely on the scholastic average. Therefore, not all who meet the scholastic requirements can be admitted.

Graduate Study by Seniors at the University of Illinois. A senior at the University of Illinois whose academic average for his junior and senior work is 4.0 or above may apply for admission to the Graduate College if he is *within five hours* of his baccalaureate degree. If he is *within ten to six hours* of that degree he may apply to take some work for graduate credit. Forms describing the procedure to be followed are available at the Graduate College Office.

Readmission. A former student who has not registered for one or more semesters must file an application for readmission. This form should be submitted to the Office of Admissions and Records several weeks before the beginning of the term in which he expects to register. A nonrefundable deposit of $30.00 on tuition and fees is required of all students seeking readmission, unless they have been assured of the award of a fellowship, assistantship, or tuition and fee waiver.

Students from Abroad. A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Office of Admissions and Records, 100a Administration Building, Urbana, Illinois, enclosing copies of his academic records certified by the educational institutions he previously attended. Since it is not advisable to undertake a graduate program without competence in the language of instruction, a test in English is usually required of those whose native tongue is not English. Instructions concerning the test, if required, are sent to the applicant soon after his credentials have been received and evaluated.

The Director of the Office of Foreign Student Affairs, 314 Student Services Building, assists students from abroad with problems involving passports, visas, and other matters.

Program of Studies

Advisers. Every graduate student must have an adviser in the department or school in which he is a degree candidate. The adviser's primary duty is to assist in planning a program of graduate work which fits the needs of the student and satisfies departmental and Graduate College requirements. A new student should go to his major department to discuss the selection of an adviser.

Unit Credit for Courses. Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five. The normal program for an eight-week summer term is two units; the maximum permissible is two and one-half units.

Grades. Grades are recorded by letters as follows: for thesis research, S and U (satisfactory and unsatisfactory); for courses, A, B, C, D, and E (failure). A student with three units of grade below B is disqualified as a degree candidate. If he has received two but *less* than three units of grade below B, then all units he submits for the

degree must be of A or B grade. Uncompleted work may be recorded by a deferred grade (Df); but such work, except that of thesis research, must be completed no later than the end of the next semester in which the student is registered.

Residence. Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable portion of his time to graduate studies. A student who is regularly employed outside the Champaign-Urbana community is not considered to be in residence even though he is registered in a campus course.

Time Limit for Advanced Degrees.

(1) A candidate for the master's degree must complete all requirements for the degree within five calendar years after his first registration in the Graduate College.

(2) A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in paragraph (3) below.

(3) A candidate for the doctorate who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. This same regulation applies to the candidate who has received his master's degree from the University of Illinois and whose studies were interrupted immediately thereafter, provided not more than the minimum number of units required for the master's degree are applied to the doctorate.

Work Completed Elsewhere. A candidate for the doctorate, who has received a master's degree from a recognized institution, will receive the equivalent of eight units of credit for that work. If such credit is to be used in partial fulfillment of the requirements for the doctorate, he will be examined on the content of the courses involved at the time of the preliminary examination.

A student who has completed graduate work in a recognized institution, but without receiving a degree, may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for an advanced degree.

Traveling Scholar Program. The University of Illinois is one of eleven midwestern member universities of the Committee on Institu-

tional Cooperation and a participant in the Committee's Traveling Scholar Program. This program enables an advanced graduate student to work at another campus for a semester in order to take advantage of special course offerings or research facilities, such as a unique laboratory or library collection, not available at his own institution. A CIC Traveling Scholar registers at his home university, and credit for the work is recorded there. Appointment as a Traveling Scholar is based upon the individual submission to the Graduate College of an application which carries the strong endorsement of the student's major department and the approval of the host institution. Each university retains the right to accept or reject any student desiring to study under its auspices. A student interested in participating in the program should consult with the head of his major department.

Auditing Privileges. A graduate student or a person not registered in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a form bearing the approval of the instructor and the Dean of the Graduate College is filed with the Recorder. A student should not enter on his program card any courses which he plans to attend as an auditor.

Extramural Courses. Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor more than one unit in any combination of extramural and campus courses.

Extramural course work is not considered work in residence and credit earned in such courses can be applied to an advanced degree only if: (1) the courses are approved in advance by the adviser and constitute part of a well integrated program, and (2) the total extramural credit does not exceed two units (the Ed.M. and the Advanced Certificate excepted). Credit earned in extramural courses is not accepted in partial fulfillment of the requirements for the second stage of a doctoral program (see page 24).

Correspondence Courses. Credit earned in correspondence courses cannot be applied toward an advanced degree. However, it is possible to fulfill certain prerequisites or remove deficiencies through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 104 Illini Hall.

Graduate Programs for Employed Students. A student who is employed cannot expect to complete his academic work as rapidly as one

who devotes full time to his academic program. The academic work carried by assistants and others on the University staff is limited by statute, and those employed outside the University are expected to reduce their programs of study in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Nature of Appointment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1¼ units
Two-thirds time	2¼ units	1½ units
One-half time	3 units	1¾ units
One-third time	3¾ units	2 units
One-fourth time	4 units	2 units

Exceptions to the *semester* schedule are possible by means of a special petition procedure. This privilege does not apply to Summer Session.

Conferring of Degrees. Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August. No more than two graduate degrees will be conferred for work completed at the University of Illinois.

Petitions. The normal procedures and requirements of the Graduate College are indicated in this catalog. A student may petition to the Dean of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms for such petitions may be secured at the Graduate College Office.

The Master's Degree

Master's degrees are offered in the fields indicated on pages 8 to 10. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units. Three of the eight units must be in courses numbered in the 400 series, and two of these three must be in the major field.

Residence. A candidate must spend at least two semesters, or the equivalent, in residence and must earn at last half the required units while in residence.

Major Requirements. At least four units of work must be in the area of concentration. The remaining credit may be in that field or in other courses appropriate to the student's educational goals.

Thesis. A student electing or required to write a master's thesis should file the subject of the thesis at the Graduate College Office at least six prior to graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research cannot be applied to a degree unless a thesis is submitted.

For specific instructions regarding the format of the thesis, the student should obtain a copy of the leaflet, "Instructions for Preparation of Theses," from the Graduate College Office.

Teacher-Education Programs. Programs leading to the master's degree for teachers are available in the areas listed below. Students who have not met all the requirements of a four-year undergraduate curriculum for teachers but who wish to take the fifth year of work for a master's degree may register with the permission of the adviser and of the Coordinator of Teacher Education. Such students will be expected to qualify for teacher certification in addition to completing degree requirements. The special requirements for each of these programs are given on the pages indicated.

Agricultural Education—page 54
Art—page 71
Biological Sciences and General Science—page 215
Chemistry—page 88
Commercial Teaching—page 83
Education of the Deaf—page 127
Education of Mentally Handicapped Children—page 127
English—page 154
French—page 168
Geography—page 172
German—page 180
Health Education—page 183
Home Economics—page 192
Latin—page 108
Mathematics—page 244
Music—page 265
Physical Education—page 281
Physical Sciences—page 283
Physics—page 283
Russian—page 310
Social Studies—page 313
Spanish—page 325
Speech—page 329
Speech Correction—page 329

In addition to the curricula listed above, programs leading to the master's degree in education with emphasis in a number of teaching fields are described on page 127.

The Degree of Doctor of Philosophy

The degree of Doctor of Philosophy is offered in the fields indicated on pages 8 to 10. The general requirements for this degree are described below and any special requirements are given in the departmental listings. For information concerning professional degrees at the doctoral level in business administration, education, law, and music, see the appropriate departmental sections.

Residence. A doctoral program includes three stages of progress, as defined below. At least two of these stages must be completed in residence and this period in residence must include two successive semesters in the second or the third stage.

The first stage is completed when the candidate has received a master's degree or has earned the equivalent number of credits (eight units or thirty-two semester hours); *the second stage* consists of eight units of work, fulfillment of the major and minor course requirements, the language requirements (if not completed earlier), and a successful preliminary examination; *the third stage* is devoted to research and seminars (eight units), the preparation of the dissertation, and the final examination.

It is possible to complete these three stages in three years if the student devotes full time to his academic program. For information concerning the maximum time allowed, see page 20.

Major and Minor Subjects. A candidate is expected to declare a major field of study and one minor (requiring four units) or two minors (requiring two units each). If he elects two minors, only one of them may be a division of the major department or field; a full minor must be entirely outside the department offering the major. The requirements for a minor in any field should be checked with the department concerned.

Language Requirements. A candidate must demonstrate ability to read two of the following languages: French, German, Russian. A student who plans to become a candidate for the Doctor of Philosophy degree should qualify in at least one of the required foreign languages during his first year of graduate study. A student must apply to take the examination in French, German, or Russian well in advance of the examination date. (See pages 11 to 16 for deadlines.) The entire language requirement should be satisfied early in the doctoral program, in any event no later than two months before the preliminary examination, or during the semester (or summer session) preceding admission to the preliminary examination.

Students may satisfy the language requirement by (1) direct examination, or (2) obtaining grades of A or B in French, German, or Russian 401; however, those majoring in history or philosophy must meet this requirement by direct examination. A student is not permitted to take the direct examination in any language more than twice. Certification of proficiency in foreign languages from other colleges or universities is not accepted by transfer.

Doctoral Committee. A permanent doctoral committee to conduct the preliminary and final examinations is appointed by the Dean of the Graduate College upon recommendation of the executive officer of the department in which the student is doing his major work.

Preliminary Examination. A candidate for the doctor's degree must pass a preliminary oral examination to test his knowledge of his major and minor fields of study. He is not admitted to the examination until (1) he has fulfilled the language requirement; (2) he has satisfactorily completed at least sixteen units of graduate work; and (3) the departments of his major and minor fields of study consider, as a result of written examination or otherwise, that he has adequate preparation.

Thesis. The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination. After passing this examination, the candidate *must* register each term (summer sessions excluded) until he receives his degree. When the credit requirement is satisfied—eight units of thesis research subsequent to passing the preliminary examination—the student maintains his status as a candidate by registering for zero credit in Thesis Research (499).

Directions regarding the format of the thesis are given in the leaflet, "Instructions for Preparation of Theses," which may be obtained in the Graduate College Office.The candidate must submit to the Graduate College, no later than the date specified in the current Calendar, (1) the original and first carbon copy (or two copies reproduced by an approved method) of his thesis, and (2) one typewritten copy of an abstract not exceeding six hundred words.

Each candidate who passes the final examination must pay a $25.00 microfilm fee. This provides for (1) microfilming the complete thesis, with one copy deposited in the University of Illinois Library, and (2) publication of the abstract in *Dissertation Abstracts.*

Final Examination. After the credit requirements for the third stage have been satisfied, and the thesis completed, the candidate is admitted to the final examination upon recommendation of the major department.

University Resources

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 3,747,000 volumes, all but about 275,000 of them located in Urbana. The remainder are held by the Library of Medical Sciences in Chicago and the library at Chicago Circle.

In addition to the figures for catalogued volumes cited above, the University Library contains approximately 489,000 pamphlets, 293,000 maps and aerial photographs, and 284,000 music scores and parts. More than 18,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archaeology; sixteenth- and seventeenth-century English literature, especially the Milton-Shakespeare period; nineteenth-century English literature, American humor and folklore; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

In the social sciences, The Library's holdings are significant for western United States history, Abraham Lincoln and the Civil War, Latin American history of the Revolutionary period, Italian history, medieval and modern European history, German history for 1830-1900, Irish history, international law and relations, political science, law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering and agriculture.

The Library's bibliographical facilities comprise a general catalog of more than 4,000,000 cards, a union catalog of titles owned by about two dozen major American and foreign libraries; printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained. Following are the principal collections in the main library building: Browsing Room; Classics; Commerce; Education and Social Science;

English; History and Philosophy; Human Relations Area Files; Library Science; Map and Geography; Modern Language; Newspaper Library; Physical Education; Rare Book Room, and Undergraduate Library.

Elsewhere on the campus are departmental libraries for the following fields: Agriculture, Architecture and Fine Arts, Biology, Ceramics, Chemistry, City Planning, Engineering, Geology, Home Economics, Journalism and Communications, Labor and Industrial Relations, Landscape Architecture, Law, Mathematics, Music, Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are the general bookstacks, housing about 2,000,000 volumes, and over 300 carrels in the bookstacks, assigned to individuals engaged in extended study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Digital Computers. See Department of Computer Science, page 115.

Electron Microscope Laboratory. The Electron Microscope Laboratory, located in the basement of Bevier Hall, is a central facility for instruction and research in behalf of all University departments. It is equipped with a Siemens Elmiskop I, an Hitachi HS-6, and RCA models EMU-3C, EMU-2F, EMT, and EMC electron microscopes. Ancillary equipment includes two ultramicrotomes, a shadow-caster, an RCA electron diffraction unit, and complete darkroom and general facilities.

The instructional program consists of the following courses: Biology, Chemistry, or Zoology 423, Electron Microscopy; Biology, Chemistry, or Zoology 429, Electron Microscopy Laboratory; Zoology, Entomology, Microbiology, or Physiology 430, Biological Ultrastructure; and seminars and special workshops. The facilities are available for research conducted by qualified faculty-staff members and graduate students.

Physical Environment Unit. The facilities of the Physical Environment Unit provide unique opportunities for pursuing interdisciplinary researches on the responses of biological systems to stresses imposed by the physical environment. An altitude chamber accommodating six human beings permits simulation of altitudes up to 45,000 feet. Air temperature and humidity may be controlled in this chamber

to permit investigation of the combined stresses of low environmental pressure and heat or cold. Additional controlled environment rooms provide flexible areas where special test facilities may be installed. All departments and divisions of the University needing closely controlled environmental conditions for research or instructional work are encouraged to utilize the special skills and equipment available in the Unit. Although primarily designed for studies with human subjects and animals, engineering and physical science projects are not excluded, if space is available.

Radiocarbon Laboratory. The Radiocarbon Laboratory, an all-University facility maintained and directed by a permanent staff, conducts research on chemical, physical, and biological problems by use of the tracer technique with carbon-14. Modern radiochemical equipment for the synthesis, degradation, isolation, and assay of radioactive carbon compounds is available.

A carbon-14 course, Chemistry or Animal Nutrition 496, introducing radioactive carbon as a unique and potent tool of investigation and emphasizing experimental techniques, is conducted by the staff one semester each year and is a prerequisite for student research in the Laboratory.

Financial Aid and Fees

Financial Assistance

Various types of financial assistance are available each year to promising students in all fields of study in the Graduate College. Detailed information about qualifications and application procedures for these awards is given in the brochure, "Financial Aid for Graduate Students," which may be obtained by writing to the Graduate College or to any of the graduate departments.

The principal kinds of awards are as follows:

University Fellowships. University Fellowships, which are awarded on the basis of an all-University competition, are generally unrestricted as to the student's field of graduate study and provide stipends of not less than $1,800 for the academic year, or $2,250 for eleven months, with exemption from tuition and all regular fees which are assessed at the time the student registers. A student receiving a University Fellowship may accept, if offered, a part-time teaching assistantship to a maximum of one-quarter time. University Fellows must carry a full program—four units or the equivalent.

A number of fellowships are also provided for teaching assistants for the summer session only. These fellowships are restricted to graduate students who have held teaching assistantships at the University of Illinois for at least half-time for both semesters of the preceding academic year, who have earned not less than two units of graduate credit during that year, and who have demonstrated superior scholarship. Like regular University Fellows, they are selected on the basis of an all-University competition. The Summer Fellowships carry stipends of $450 for the eight-week summer session, plus tuition and fee exemptions.

In addition to the all-University awards, there are offered a number of Fellowships in the Creative and Performing Arts. These awards are made primarily on the basis of the applicant's creative achievements and promise rather than on his academic and scholarly qualifications. Eligible for these fellowships are students in the fields of dance, theatre, architectural design, landscape architecture, painting and printmaking, graphic design, industrial design, and music. Applicants may contact the appropriate department.

Industrial, Endowed, Special Fellowships, and Traineeships. Various industrial firms, foundations, government agencies, and private individuals have generously donated funds to support a number of special fellowships for graduate students at the University of Illinois. The stipends and supplemental allowances of these fellowships are not uniform, and most of them are restricted to students in particular areas of study. Brief descriptions of the names, donors, fields, and other conditions pertaining to each are presented in the brochure, "Financial Aid for Graduate Students," referred to above.

National Science Foundation Cooperative Graduate Fellowships. These fellowships are financed by the National Science Foundation, but are administered with the cooperation of the participating universities, including the University of Illinois. They are restricted to United States citizens who are graduate students in the mathematical, physical, medical, biological, and engineering sciences, and in certain other fields regarded as employing scientific methods. Each carries a stipend of $2,400 for the first year ($1,800 for nine months), $2,600 for the intermediate year, and $2,800 for the terminal year, plus exemption from tuition and all regular fees which are assessed at the time the student registers. An allowance of $500 is granted for each dependent. An applicant for a Cooperative Fellowship must send his application by November 1 to the university at which he proposes to pursue his graduate studies, not directly to the National Science Foun-

dation. Anyone who wishes to apply may secure application materials from the Graduate College or from the National Science Foundation.

National Science Foundation Traineeships in the Engineering, Mathematical, and Physical Sciences. Under this program grants are made directly to the participating institutions, who select a specific number of promising individuals for full-time graduate study. Appointments may be made only to citizens of the United States (or native residents of a United States possession) who are enrolled in programs leading to an advanced degree in the engineering, mathematical, and physical sciences.

Stipends are the same as for the NSF Cooperative Fellowships above. Inquiries concerning traineeships should be directed to the appropriate department at the University.

National Defense Graduate Fellowships. The University of Illinois Graduate College has a number of National Defense Graduate Fellowships which are financed under Title IV of the National Defense Education Act of 1958, and administered with the cooperation of participating universities. This program assists students who are preparing to teach in the nation's colleges and universities. Each fellowship, restricted to citizens or permanent residents of the United States, is for a three-year period to a student beginning his graduate studies. The stipend for the academic year is $2,000 for the first year, $2,200 for the second, and $2,400 for the third, plus an allowance for dependents. These fellowships provide exemption from tuition and all regular fees which are assessed at the time the student registers. A holder of a Title IV fellowship may, under certain conditions, also be appointed as a part-time teaching assistant.

Under Title VI (Modern Foreign Languages) of the National Defense Education Act, the University of Illinois participates in programs in Russian and in Latin American Language and Area Studies. These fellowships, restricted to citizens or permanent residents of the United States, are intended for students planning a college or university teaching career or other career centering on problems of the language area. The stipend for the fellowship, which is renewable, is $2,250 for the academic year, or $2,700 for the summer and academic year, plus an allowance for dependents. Holders of Title VI fellowships are not exempt from payment of tuition and fees.

For complete information and application materials concerning current programs, the student should write to his prospective major department.

National Aeronautics and Space Administration Traineeships. The National Aeronautics and Space Administration sponsors a number of traineeships at the University of Illinois for students who are majoring in the space-related sciences and technology. Awards are made to first-year graduate students and provide an annual tax-free stipend of $2,400 for twelve months, with exemption from tuition and all regular fees that are assessed at the time of registration. An allowance of up to $1,000 is provided for dependents, and the traineeship may be renewed for a total of three years. NASA trainees must carry a full program—four units or the equivalent. Inquiries concerning this program should be directed to the student's prospective major department.

Assistantships. The various departments of the University employ a number of graduate students as teaching or research assistants. The usual appointment is for half-time service, at a salary of $2,250 for the academic year (September to June). Applications may be made directly to the appropriate department.

Assistants holding appointments ranging from 25 through 67 per cent of full-time service are exempt from the tuition and service fees, but not from the hospital-medical-insurance fee. For more detailed information concerning fee assessment, see pages 32 to 38.

There are also a number of part-time assistantships available in non-teaching bureaus and agencies. For further information and application materials, write directly to: Bureau of Business Management, Bureau of Community Planning, Bureau of Economic and Business Research, Center for Instructional Research and Curriculum Evaluation, Department of Computer Science, Institute of Communications Research, Institute of Government and Public Affairs, Institute for Research on Exceptional Children, Physical Environment Unit, and Small Homes Council-Building Research Council. All agencies may be addressed in care of University of Illinois, Urbana.

Part-time appointments as student residence hall counselors are also available. These provide cash stipends plus room and board and the same exemption from tuition and the service fee accorded other staff members. For further information, students should write to the Dean of Men or the Dean of Women, Student Services Building.

Tuition and Fee Waivers. These awards provide exemption from the tuition and service fee, but not from the hospital-medical-surgical insurance fee, for the academic year and the summer session immediately following. Students holding these awards must be in residence and must register for at least three units each semester during the

academic year. They may, however, accept part-time or incidental employment not to exceed twenty hours a week either within or outside the University.

How to Apply. Application materials with instructions may be obtained from the Graduate College or from any graduate department. Only one application form is needed to apply for any of the types of financial aid listed above, excepting the National Science Foundation Cooperative Graduate Fellowships, which require an additional special form. To be considered for a University Fellowship beginning in June or September, the application must be filed with the major department no later than February 15. Applications for tuition and fee waivers and assistantships are accepted after that date, but applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer assistantships at the same time they consider applications for fellowships. An age limit of thirty-five years applies to applicants for University Fellowships and Tuition and Fee Waivers.

Announcement of Awards. Fellowship awards are announced by the Graduate College on or about April 1. Recipients are expected to accept or decline by April 15.

The University of Illinois adheres to the following resolution adopted by the members of the Association of American Universities and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom to reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

Loan Funds. Loan funds have been established for the benefit of worthy students in the University who need financial assistance. Application blanks may be secured from the Dean of Students' Office, 313 Student Services Building.

Fees

Tuition and other fees, as indicated below, are payable in full when the student registers, unless the installment plan of payment is elected. An additional charge of $2.00 is made for this privilege.

The following rates for tuition and fees are effective September 1, 1965:

SEMESTER TUITION AND FEES

	Full Program		*Partial Programs*			
	Range I Above 10 hours Above $2\frac{1}{2}$ units		**Range II** Above 5 to 10 hours Above $1\frac{1}{4}$ to $2\frac{1}{2}$ units		**Range III** Above 0 to 5 hours Above 0 to $1\frac{1}{4}$ units	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 85.00	$375.00	$60.00	$265.00	$35.00	$155.00
Service Fee[1]	40.00	40.00	25.00	25.00	10.00	10.00
Hospital-Medical-Surgical Insurance Fee[2]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$135.00	$425.00	$95.00	$300.00	$55.00	$175.00

EIGHT-WEEK SUMMER SESSION TUITION AND FEES

	Full Program		*Partial Programs*			
	Range I Above 5 hours Above $1\frac{1}{4}$ units		**Range II** Above $2\frac{1}{2}$ to 5 hours Above $\frac{3}{4}$ to $1\frac{1}{4}$ units		**Range III** Above 0 to $2\frac{1}{2}$ hours Above 0 to $\frac{3}{4}$ unit	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 45.00	$190.00	$30.00	$130.00	$20.00	$ 80.00
Service Fee[1]	20.00	20.00	15.00	15.00	5.00	5.00
Hospital-Medical-Surgical Insurance Fee[2,3]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$ 75.00	$220.00	$55.00	$155.00	$35.00	$ 95.00

[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off-campus are exempt from the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of this fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed waiver and assumption of responsibility is required. Persons registered for thesis research *in absentia* are not assessed this fee.

[3] If insurance coverage for the period between the close of the summer session and the beginning of the first semester is not desired, $5.00 will be refunded if requested in writing prior to the final date established for full refund of fees.

SPECIAL FEES

Below is a partial list of special fees pertaining to graduate students. A complete schedule of tuition and fees may be obtained from the Office of Admissions and Records, 100a Administration Building.

Late Registration Fine—$15.00. All students, whether on appointment or not, who complete registration for courses on campus after the close of the regular registration, are subject to this fine in addition to the tuition and fees. A student's registration is not complete until his tuition and fees have been paid in full, or he has made arrangements with the Bursar's Office for deferment of payment. Students who register late in any term pay the same tuition and fees as students who register at the beginning of the term.

Change of Program Fee—$1.00. This fee is charged for every change slip issued at the request of the student after the completion of registration.

Noncredit Registration in Thesis Research (499) on Campus. Students registered on campus for thesis research only without credit are charged a tuition fee of $10.00, plus a service fee of $10.00 for a semester or $5.00 for a summer session, and the hospital-medical-surgical insurance fee.

In Absentia. Students registered for thesis research *in absentia* without credit are charged only a tuition fee of $10.00; those registered for credit pay the regular tuition, resident or nonresident, as applicable.

ASSESSMENTS AND EXEMPTIONS

Assessments. For fee assessment purposes, a staff appointment must require service for not less than three-fourths of the term. This is interpreted as a minimum of three and one-half months in a semester, nine weeks in a quarter, and six weeks in an eight-week summer session. Staff tuition and fee privileges do not apply to students employed on an hourly basis in either an academic or nonacademic capacity, or to persons on leave without pay.

Any student who resigns his staff appointment, or whose appointment is cancelled before rendering service for at least three-fourths of the term, becomes subject to the full amount of the appropriate tuition and fees for that term unless he withdraws from his University classes at the same time the appointment becomes void.

Exemptions. A student may be exempted from one or more of the usual charges if he qualifies under the following conditions:

Tuition is waived for:

(1) Holders of tuition waiver scholarships.
(2) All academic employees of the University or of allied agencies on appointment for at least 25 per cent but not more than 67 per cent of full-time services.
(3) All permanent nonacademic employees of the University or allied agencies on appointment for at least 25 per cent of full-time who register in University courses in Range II or III.
(4) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(5) Holders of grants or contracts from outside sponsors which provide payments to cover the total costs of instruction.
(6) Cooperating teachers and administrators who receive assignment of practice teachers. (Exemption is provided in one term for each semester of assignment within the same calendar year—September through August.)
(7) Persons registered in noncredit seminars only.
(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

Nonresident portion of tuition (if subject to payment of tuition) is waived for:

(1) All staff members (academic, administrative, or permanent nonacademic)—on appointment for at least 25 per cent of full time with the University or the allied agencies.
(2) The faculties of state-supported institutions of higher education in Illinois.
(3) The teaching staff in the private and public elementary and secondary schools in Illinois.
(4) The spouses and dependent children of those listed in items 1 and 2 above. (Dependent children are those who qualify as dependents for federal income tax purposes.)
(5) Persons actively serving in one of the Armed Forces of the United States who are stationed and present in the state of Illinois in connection with that service.
(6) The spouses and dependent children of those listed in item 5 above, as long as they remain stationed, present, and living in this state.

For those listed in items 1 through 4 above who are eligible for

such waiver in the final term of the academic year, except as indicated under Summer Session below, this privilege is also extended to the summer session immediately following.

Service fee is waived for:

(1) All staff members of the University or allied agencies on appointment for at least 25 per cent of full time.
(2) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(3) Students registered *in absentia.*
(4) Students registered in courses taught off campus.
(5) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(6) Cooperating teachers and administrators described in item 6 above (under tuition waivers).
(7) Persons registered in noncredit seminars only.
(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

Hospital-medical-surgical insurance fee is waived for:

(1) Students presenting evidence of equivalent coverage upon approval of a petition presented to the University Insurance Office not later than the final day established for full refund of fees.
(2) Persons registered for thesis research *in absentia.*
(3) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(4) Students for whom this fee has been assumed by the Graduate College.
(5) Persons registered in noncredit seminars only.
(6) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.

Summer session tuition and fees are waived for:

(1) Students holding academic appointments to the close of the final term of an academic year either as employees or fellows, and for whom tuition and/or fees have been provided through waiver or through cash payment by an outside agency, are entitled to a waiver of the same kinds of tuition and fees for the summer

session immediately following, provided they hold no appointments during that summer session.

(2) Students holding summer session appointments as fellows or as employees are subject to such tuition and fees as would be assessed in accordance with the principles expressed above.

ADVANCE DEPOSIT ON TUITION AND FEES

Each new, readmitted, and advance enrolled continuing student (except foreign students who, at the time of application, are residing outside the United States, and certain others specifically exempted) who wishes to register for a fall semester is required to make an advance deposit in order to secure the place reserved for him. New and readmitted students wishing to enroll in the spring semester are also required to make an advance deposit.

This is not an additional cost for attending the University but is applied to each student's tuition and fees in the semester for which he is approved. In case the student fails to enter the University in that semester, the deposit may not be applied toward any future registration. The deposit should not be sent until requested by the University. It is nonrefundable except in very special cases.

The following graduate students may confirm their intentions to register without payment of the advance deposit:

(1) All new foreign students.

(2) New, readmitted, and advance enrolled continuing graduate students holding a fellowship, academic or nonacademic staff appointment, or graduate tuition and fee waiver.

(3) New, readmitted, and advance enrolled continuing graduate students who receive a financial award from an agency outside the University, and whose complete tuition and Service Fee are billed to the agency by the Bursar.

(4) Doctoral candidates who have passed the preliminary examination.

REFUND OF FEES

A student subject to tuition and/or fees who withdraws from the University during any term, for reasons other than military or other national defense service, receives a refund as listed below. (Special refund regulations govern withdrawals for active military or other approved national defense service.)

In a semester:

(1) During the first ten days of instruction in a semester, refund is made of the full amount of the tuition and fees assessed except for a

nonrefundable charge of $30.00.[1] When the total assessment has been less than $30.00, the full amount of the assessment, if any, is nonrefundable.

(2) After the first ten days but within the first half of the semester, one-half of the total amount of the tuition and fees assessed which remains after deduction of the nonrefundable charge is refunded.

(3) After the midpoint of the semester, no refund is allowed.

In an eight-week summer session:

(1) During the first five days of instruction in the summer session, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $15.00.[1] When the total assessment has been less than this amount, the full amount of the assessment. if any, is nonrefundable.

(2) After the first five days but within the first half of the summer session, one-half of the amount assessed which remains after deduction of the above mentioned $15.00 is refunded.

(3) After the midpoint of the summer session, no refund is allowed.

Expenses

Although personal expenses may vary according to the individual needs and benefits, the following estimates indicate the average basic living costs for single students. Cost of daily board ranges from $2.50 to $3.00, single rooms in private student houses from $35.00 to $45.00 a month, and double rooms from $25.00 to $40.00 a month for each person. In some cases, apartments are shared and the monthly costs per person can be from $50.00 to $55.00. A graduate hall operated by the University offers single rooms at a rate of $424.00 for the academic year and double rooms at a rate of $360.00 per person for the same period. A board contract may be purchased for one semester at a rate of $240.00.

Student Services

Housing

The University has residence facilities in two separate residence hall complexes for approximately 1,000 single graduate students, both

[1] The nonrefundable charge includes the hospital-medical-surgical insurance fee, if originally paid; the student who withdraws from the University continues to be covered by the insurance until the close of the term.

men and women. In one unit, Daniels Hall, contract food service in an undergraduate dining hall located directly across the street can also be arranged. In addition, the University provides a limited number of apartments for married students, with priority in assignment given to part-time research and teaching assistants.

Applications for accommodations in the University graduate residence hall or the University-owned apartments for married students may be obtained from the Housing Division, Supervisor of Graduate Housing, 420 Student Services Building, Champaign. The Housing Division also maintains a courtesy list of private apartments and rooms available in homes in the community. Office hours are from 8:00 a.m. until 12:00 noon and 1:00 to 5:00 p.m. Monday through Friday, and from 9:00 a.m. until 12:00 noon each Saturday. On the two weekends prior to registration, officers hours are maintained from 10:00 a.m. until 12:00 noon and 2:00 to 4:00 p.m. on Saturday and Sunday. University offices are not open on national holidays.

Vehicle Regulations

All resident students enrolled in the Graduate College who have a motor vehicle in their possession are required to register this vehicle with the Motor Vehicle Division.

Graduate students holding at least one-half time teaching or research appointments are included under the term "faculty-staff" and have the option of purchasing an "E" permit or securing a "G" permit with reduced privileges at no cost. Fellowship holders are accorded these same privileges.

All other students who possess and maintain a car in the Urbana-Champaign community are assessed a fee of $15.00 per year ($7.50 per semester) and are issued the appropriate sticker.

The Motor Vehicle Division requires the registration of all motorcycles, motor scooters, and motor bicycles. The fee for such registration is $3.00 per year.

Bicycles also must be registered with this Division. No fee is charged for such registration.

Questions relating to vehicle regulations should be referred to the Motor Vehicle Division, 101 North Mathews Avenue, Urbana.

Military Deferment

Students being deferred from military service for educational purposes periodically must file a "Status Form" with the Office of Admissions and Records so that accurate information will be available

when local boards request reports. Copies of this "Status Form" may be obtained at Window 20, 100a Administration Building, from the departmental offices, or from the Graduate College Office.

Social and Cultural Facilities

Students at the University of Illinois have a wide choice of activities and facilities available to them. Campus events announced in a weekly calendar include musical programs, lectures, University forums, campus and traveling theatrical productions, weekend movies and dances, and fine arts and scientific exhibitions.

The Krannert Art Museum provides galleries for displaying the University's permanent collection of art works and for presentation of other exhibitions. A University Festival of Contemporary Arts, held every two years, includes special events and exhibits in the areas of art, architecture, landscape architecture, urban planning, drama, motion picture, literature, printing, dance, and music. Illini Union, the campus social center, has lounges, dining facilities, and recreational and meeting rooms available to students and faculty.

Fields of Instruction

Courses open to graduate students are of two types. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only. Those numbered 500 to 599 are open only to graduate students in certain professional programs.

All courses for graduate students require previous preparation. By consultation with the instructor, a student may determine whether he has had the necessary prerequisites for a particular course.

Courses in this bulletin are listed alphabetically by departments. The offerings in each field are arranged numerically in groups, with headings to indicate the students for whom they are designed. The 400 series are listed first; courses in the 300 series follow. After the title of each course is a brief description of its contents, the credit given, and the requirements for admission to the course.

A number of courses offer variable credit. At the 300 level, additional work in the nature of special reports, papers, or projects is required of a student who registers for the maximum credit shown. In each case, the student, with the help of his adviser, will determine whether or not his schedule allows sufficient time to complete the work required for maximum credit.

At the 400 level, research, reading, and independent study courses provide variable credit; proportionate time devoted to a particular activity can thus be indicated on the student's record.

Unless otherwise specified, it can be assumed that a course is offered at least once during each calendar year. Courses offered only in the summer session are indicated by "S"; courses given in alternate years are indicated with the year of offering. A complete listing of courses for each term is contained in the Time Table, published about six weeks prior to the beginning of each term and available from the Graduate College, 330 Administration Building.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the Master of Science and Doctor of Philosophy in Accountancy, and to the Master of Accounting Science. The minimum grade-point average for admission to graduate study in the department is 3.75.

Master of Science. A candidate for the Master of Science must have had the equivalent of twenty hours of undergraduate work in accountancy and at least one course each in principles of economics and finance. Eight units are required; at least four of them must be in courses in the 400 series. Two of the eight units must be earned in connection with a thesis, and the candidate is ordinarily expected to take Accountancy 481 and 483. The remaining four units of the eight required for the degree are elected by the student upon the approval of his adviser. The candidate may elect one or more minors but must have at least four units in accountancy.

Master of Accounting Science (professional degree). This program is designed for candidates who wish to prepare for professional careers in public, governmental, or industrial accounting. Candidates must present at least twenty-four semester hours of undergraduate work in accountancy, including a course in each of these areas: cost accounting, federal income tax accounting, auditing, and advanced problems. Eight units of graduate credit, including Accountancy 481, 483, and 594, are required. In addition, one or more minors of one to four units in a field or fields outside the area of accountancy are required.

Each candidate may declare his intention of preparing for public accounting, governmental acounting, or industrial accounting. Those intending to enter public accounting ordinarily take, in addition to the required courses previously mentioned, at least three of the following courses, including the first two named: Accountancy 472, 577, 471, 325, 372, and 374.

Those preparing for careers as comptrollers, chief accountants, cost accountants, or executive positions in industrial or commercial enterprises ordinarily take at least three of the following courses, including the first two named: Accountancy 566, 461, 466, 473, 325, 362, and 366.

Those preparing for careers in local, state, or federal governments, or for accounting or administrative positions in nonprofit organizations, institutions, or government agencies ordinarily take at least three of the following courses, including the first two named: Economics 414, Accountancy 441, 455, 461, 466, 325, and 341.

Program for Non-Commerce Graduates. A program is available which permits non-commerce graduates to earn a Master of Science in Accountancy or a Master of Accounting Science degree in approximately two years. Students with undergraduate degrees, but with no undergraduate work in accountancy, may remove entrance deficiencies during the first year by registering in the combined courses, which carry no graduate credit. These students then proceed with the regular graduate program during the second year of residence. Requests for further information should be addressed to the head of the department.

Doctor of Philosophy. A candidate for the Doctor of Philosophy must satisfy the general Graduate College requirements noted on pages 23 to 25. In his preliminary examination, the candidate must show a thorough knowledge of accounting theory, a thorough knowledge of certain areas of accountancy, the number and selection to be determined by the adviser in consultation with the student, and a general acquaintance with the subject matter and bibliography of other areas of accountancy.

GRADUATE FACULTY

Professors: C. A. Moyer (Head of Department), N. M. Bedford, E. J. DeMaris, R. I. Dickey, Dorothy Litherland, G. E. Lukas, R. K. Mautz, K.

W. Perry, D. H. Skadden, W. E. Thomas, N. D. Wakefield, A. R. Wyatt, V. K. Zimmerman.

Associate Professors: G. D. Brighton, P. E. Fess, H. P. Holzer, R. E. Schlosser.

Assistant Professors: D. J. Casler, W. A. Peterson, H. M. Schonfeld.

PROFESSIONAL COURSES

566. Accounting Problems of Industrial Management. A development of the role and importance of cost and revenue data in the process of enterprise administration. Attention is focused on the goals of the firm and the possible aid in achieving these goals that would come from properly conceived, prepared, and utilized cost and revenue data. For Master of Accounting Science and Master of Business Administration students only. 1 unit. Schonfeld.

577. Professional Problems. Instruction as to types and methods of solution of professional problems in public accounting; including practice in analyzing and solving a wide variety of such problems. For Master of Accounting Science students only. 1 unit. Perry, Skadden.

594. Methods and Practices in Professional Research. Instruction in research methods, materials, and techniques together with individual practice in conducting and reporting on specific professional research projects. For Master of Accounting Science students only. 1 unit. Casler, Zimmerman.

COURSES FOR GRADUATES

432. Accounting Under Different Social Systems. An inquiry into the ways accounting has been adapted to the needs of different social systems; the extent of its contribution; its apparent limitations. Consideration is also given to the relationship between accounting and the growth and development of social systems. 1 unit. Prerequisite: Consent of instructor. DeMaris.

441. State and Federal Accounting Theory. Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. 1 unit. Lukas.

455. Macro-Accounting. Same as Economics 425. An examination of the fundamental concepts underlying the attempts to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor. DeMaris, Zimmerman.

461. Administrative Accounting. Accounting as a tool for management; organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. 1 unit. Holzer, Thomas.

466. Cost Accounting Theory and Analysis. A critical examination of cost accounting methods as to truth and expediency. 1 unit. Dickey, Holzer.

471. Accounting Reports. Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. 1 unit. Wakefield.

472. Auditing Standards and Techniques. A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. 1 unit. Mautz, Moyer, Wyatt.

473. **The Theory of Accounting System Design.** Problems and procedures in connection with designing and installing accounting systems. 1 unit. SCHLOSSER, THOMAS.

474. **Income Tax Development.** A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. 1 unit. BRIGHTON, SKADDEN.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. 1 unit. BEDFORD, MAUTZ, MOYER, WYATT.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. 1 unit. BEDFORD, FESS, PERRY.

484. **The Accounting Theory of Business Income.** An examination of the development and essential characteristics of the accounting theory of business income evaluated in the light of criticisms implicit in other concepts of income; the social significance of business income theory. 1 unit. MAUTZ.

485. **Relationship of Accounting Theory to Philosophy, Science, and Other Disciplines.** An examination of the relationship of accounting theory to the developments, thoughts, and methods in the fundamental intellectual disciplines. 1 unit. BEDFORD.

487. **Surplus and Dividends.** The theories underlying the treatment of balance sheet items deserve close consideration in accounting, because the balance sheet reflects the effect of conflicting ideas about the bases for setting up restrictions on the freedom of directors to dispose of corporation assets as dividends. 1 unit. PERRY.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. 1 unit. ZIMMERMAN.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. ¼ to 2 units. MOYER.

499. **Thesis Research.** Individual direction and guidance in writing theses, and seminar discussions of progress made. 0 to 4 units. MAUTZ, WAKEFIELD, STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. ¾ unit. Prerequisite: Accountancy 106 or 166, and 108; an average of C or better in preceding courses in accountancy. BEDFORD, CASLER, PERRY, PETERSON.

325. **Accounting System Design.** An introduction to the fundamentals of accounting system design. This includes the design and use of business papers, records, and reports; the functions of business machines in accounting systems; and personnel problems in accounting system design. ¾ unit. Prerequisite: Accountancy 308. HOLZER, SCHLOSSER.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. ½ unit. Prerequisite: Accountancy 108. BRIGHTON, LUKAS.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. ¾ unit. Prerequisite: Accountancy 108. HOLZER, SCHONFELD, THOMAS.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. DICKEY, HOLZER, SCHLOSSER, SCHONFELD.

371. **Auditing.** Nature of audit evidence, basic audit techniques, audit practices and procedures, professional ethics, audit reports. ¾ unit. Prerequisite: Accountancy 308. FESS, MAUTZ, WAKEFIELD.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. ¾ unit. Prerequisite: Accountancy 371. FESS, WYATT, ZIMMERMAN.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. ¾ unit. Prerequisite: Accountancy 274 and 308. BRIGHTON, SKADDEN.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. 1 unit. Prerequisite: Credit or registration in Accountancy 371. CASLER, PERRY, PETERSON, WYATT.

378. **Advanced Theory and Practice.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory, auditing, ethics. 1 unit. Prerequisite: Accountancy 377. PERRY, WYATT.

ADVERTISING

The Department of Advertising offers graduate work leading to the Master of Science in Advertising. For the program leading to the Doctor of Philosophy in Communications, see page 109; for programs leading to doctoral majors and minors in related fields such as marketing and psychology, consult the departmental listings.

Admission to graduate work in advertising requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in advertising or a related field, English, commerce, or the other social sciences, and (2) a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but over 3.5 are considered on an individual basis.

Master of Science. Requirements for this degree include:

(1) A major of four units, or three units and one additional unit approved by the adviser. Candidates must select at least two units from Advertising 481, 482, and 483. Advertising 382, 383, and 384 also must be included in the master's program, unless these courses, or the equivalent, were previously taken.

(2) A minor of at least two units.

(3) A thesis of one or two units.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

GRADUATE FACULTY

Professors: C. H. SANDAGE (Head of Department), L. W. MCCLURE.

Associate Professors: J. E. MOYER, H. W. SARGENT.

Assistant Professors: A. M. BARBAN, J. L. SIMON.

COURSES FOR GRADUATES

481. **Advanced Advertising Principles.** Same as Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Advertising 481 and 388. 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. SIMON.

483. **Advertising and the Mass Media.** Same as Communications 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit. MOYER.

490. **Special Topics in Advertising.** ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

499. **Thesis Research.** 1 to 2 units STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. ½ unit.

382. **Advertising Copy and Layout.** Theory and practice of advertising; message creation and arrangement for print and broadcast media; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. 1 unit. Prerequisite: Advertising 281. SARGENT.

383. **Advertising Media.** Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. ½ unit. Prerequisite: Advertising 281. BARBAN, MOYER.

384. **Advertising Campaigns.** Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements—copy and layout. ½ unit. Prerequisite: Advertising 282 or 382, and 383. MOYER.

385. **Advertising Promotion and Sales.** Sales problems, advertising promotion, advertising research, market research. ½ unit. Prerequisite: Advertising 281. MCCLURE.

386. **Radio and Television Advertising.** Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. ½ unit. Prerequisite: Advertising 281. MCCLURE.

387. **Advertising Policies and Problems.** Same as Marketing 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. ½ or 1 unit. Prerequisite: Advertising 281. WEDDING.

388. **Advertising in Contemporary Society.** A study of advertising as an institution and its role in communications, society, our economy, and business. Students may not receive graduate credit for both Advertising 388 and 481. ½ unit. Prerequisite: Advertising 281 or consent of instructor. SARGENT.

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautical and Astronautical Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy. Study and research are planned to prepare graduates for fundamental and applied work in airplane, missile, and space flight engineering. Typical areas of concentration are aerodynamics, aeroelasticity, astrodynamics, propulsion, structural mechanics, and guidance and control.

The minimum grade-point average for admission to graduate study in aeronautical and astronautical engineering is 4.0. Applications of students with grade-point averages below 4.0 but over 3.75 are considered on an individual basis.

The prerequisite for graduate study in aeronautical and astronautical engineering normally is the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical and astronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical and astronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Each student plans his study program in consultation with a departmental adviser. Courses offered by departments other than aeronautical and astronautical engineering may be included in the major area of study when these courses are of particular value to the work which students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical and astronautical engineering must have taken mathematics through the first course in differential equations and the undergraduate aeronautical and astronautical engineering courses, or their equivalents, which are prerequisites to study in the area of the minor work. Deviation from these requirements requires approval from the head of the department.

For information concerning applied mathematics, see page 252.

GRADUATE FACULTY

Professors: H. S. Stillwell (Head of Department), B. L. Hicks, H. H. Hilton, H. W. Knoebel, R. W. McCloy, A. I. Ormsbee, R. A. Strehlow, S. M. Yen.

Associate Professors: H. O. Barthel, Y. M. Lin, A. R. Zak.

Assistant Professor: C. E. Bond.

COURSES FOR GRADUATES

411. **Advanced Aerodynamics of Compressible Fluids.** Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. 1 unit. Ormsbee.

414. **Boundary Layer Theory.** Theories of the boundary layer of a compressible fluid and their solutions, laminar and turbulent; boundary layer in hypersonic flow. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 and 232, or equivalent. Yen.

415. **Wing Theory.** Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. 1 unit. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

416. **Hypersonic Aerodynamics.** Discussion of high Mach number flows including the aerodynamic effects of dissociation and ionization. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 411. ORMSBEE.

418. **Theory of Rarefied Gas Flows.** Application of kinetic theory to rarefied gas flow problems; free-molecule flow; near free-molecule flow; linearized problems; flows with appreciable deviation from equilibrium. 1 unit. Prerequisite: Physics 362. YEN.

426. **Theory of Continuous Media.** Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. 1 unit. Prerequisite: Consent of instructor. HILTON.

427. **Thermal Stresses and Creep Buckling.** Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; minimum weight and probability of failure; applications to high-speed airplane, missile, and space vehicle structures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or consent of instructor. HILTON.

428. **Theory of Large Deformations in Nonlinear Continuous Media.** Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications: generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, constituent relations for inelasticity. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or equivalent. HILTON.

429. **Theory of Linear and Nonlinear Viscoelasticity.** Fundamental concepts of viscoelasticity with applications. Elastic-viscoelastic analogies, creep and relaxation functions, thermo-mechanical reciprocity relations, variational principles, model fitting. shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, torsion of nonlinear bars and shells. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or consent of instructor. HILTON.

434. **Aerodynamic Heating.** Theory of convective aerodynamic heating in high-speed flow, laminar and turbulent flows; ablation, transpiration cooling, and mass transfer cooling; aerodynamic heating in hypersonic flow, real gas effects, effect of pressure interactions and vorticity interactions; heat transfer in rarefied gas flows. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 and 232 or equivalent. YEN.

438. **Fundamentals of Combustion.** Same as Mechanical Engineering 403. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 or Mechanical Engineering 305. STREHLOW.

451. **Aeroelasticity and Aeroinelasticity.** Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250 or consent of instructor. ZAK.

452. **Stochastic Structural Dynamics.** Fundamentals of stochastic analysis and generalized harmonic analysis. Stationary and nonstationary processes in linear systems; applications to panel vibrations induced by boundary layer turbulence and jet noise; applications to gust and landing problems; peak distributions and fatigue life; stabilities of stochastic systems; acoustical damping and apparent mass; response of nonlinear structures to random inputs. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250 or Theoretical and Applied Mechanics 412, or equivalent. LIN.

490. **Seminar.** Presentation by graduate students and staff of current topics in the fields of aeronautics. No credit. Prerequisite: Graduate standing in aeronautical and astronautical engineering. HILTON.

493. **Special Problems.** Theoretical and experimental investigations of problems in airplane, missile, and space flight engineering. 1 to 2 units. STAFF.

499. **Thesis Research.** Research in the various areas of the aeronautical and astronautical sciences. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Human Factors in Engineering for Space Travel.** Same as Physiology 304. Human factors decisive in the design and operation of manned space vehicles. ½ unit. Prerequisite: Graduate standing in biology, engineering, physical sciences, or psychology. R. E. JOHNSON, STILLWELL.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE, STILLWELL.

334. **Rocket Propulsion and Rocketry.** The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. ½ unit. Prerequisite: First course in thermodynamics or consent of instructor. MCCLOY.

391. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. ½ or 1 unit. Prerequisite: Consent of instructor. STAFF.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the Master of Science and Doctor of Philosophy. The chief fields of specialization are farm management, land economics, marketing, prices and statistical analysis, and rural sociology. Graduate work is also offered in national agricultural policies and

programs, finance, law as applied to agriculture, and in international comparative agriculture.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the Bachelor of Science in Agriculture at the University of Illinois, including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least eight hours in accountancy, business law, finance, history, management, marketing, political science, or sociology.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The grade-point average required for admission to graduate study in agricultural economics is 4.0. Applications of students with grade-point averages below 4.0 but over 3.75 are considered on an individual basis.

A candidate for the Master of Science degree is required to register for at least two units of economics, including one unit of economic theory. For the Doctor of Philosophy degree, a candidate must complete: (1) a minimum of five units in the social sciences other than agricultural economics, including three units in economic theory at the 400 level selected from Economics 400, 401, 402, 403, 404, 405, and 408; (2) one unit in each of four areas of agricultural economics—production and resource organization, agricultural economic policy, prices and markets, and inferential statistics (Agricultural Economics 404, 405, 436, and 441); and (3) one-half unit of operations research (Economics 372) and one unit of mathematics (Mathematics 358, 359). Equivalent courses completed at another institution will be accepted in fulfillment of these requirements, subject to Graduate College regulations.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics is considered a first minor, in which case the program in that minor requires the approval of the Department of Economics (see requirements in economics for a minor in that field).

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economics and agricultural subjects.

GRADUATE FACULTY

Professors: H. G. Halcrow (Head of Department), C. B. Baker, R. W. Bartlett, G. K. Brinegar, E. E. Broadbent, W. D. Buddemeier, F. Dovring, C. L. Folse, H. W. Hannah, T. A. Hieronymus, J. M. Holcomb, G. G. Judge, R. A. Kelly, N. G. P. Krausz, D. E. Lindstrom, R. J. Mutti, F. J. Reiss, R. G. Spitze. E. R. Swanson, W. N. Thompson, R. N. Van Arsdall, V. I. West, J. E. Wills.

Associate Professors: J. H. Herbst, M. B. Kirtley. S. C. Schmidt.

Assistant Professors: L. P. Fettig, J. C. Headley, H. J. Schweitzer, D. G. Smith.

Agricultural Economics

COURSES FOR GRADUATES

401. **International Comparative Agriculture.** Agricultural and food problems of the world and of selected countries viewed in the world setting; resources and institutional factors affecting production; national and international policies and plans for developing agricultural production and improving levels of living. Emphasis is given to a comparative approach to agricultural development of countries on different economic levels. 1 unit. Dovring.

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of

the farm business to uncertainty; production relationships among farms; location of agricultural production. 1 unit. Prerequisite: Economics 300 or an equivalent course in economic theory and one course in statistics. SWANSON.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. 1 unit. Prerequisite: One semester of graduate work or consent of instructor. HALCROW, SCHMIDT.

406. **Research Methodology in Agricultural Economics.** Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. 1 unit. Prerequisite: Economics 400 or 401 or a course of comparable level in the basic field related to the student's research. BAKER.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. Field trip; estimated expense, $8.00. 1 unit. WILLS.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of government agencies; cooperative efforts. 1 unit. BRINEGAR, HIERONYMUS.

441. **Agricultural Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. 1 unit. Prerequisite: An elementary course in statistics. WEST.

442. **Quantitative Analysis in Agricultural Economics.** Application of techniques of quantitative analysis in agricultural economics. Construction, estimation, and interpretation of sector, spatial, and input-output models for the agricultural economy. 1 unit. Prerequisite: Agricultural Economics 441, Economics 401, Mathematics 358, or equivalents. JUDGE.

470. **Seminar in Family and Consumption Economics.** Same as Home Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in statistics; Agricultural Economics 370 or consent of instructor. DUNSING.

491. **Seminar and Special Topics.** Each graduate student majoring in agricultural economics must register for this course. Only students who register for credit and complete special studies under the direction of one or more staff members receive credit. 0 to 2 units.

499. **Thesis Research.** Individual research under supervision of members of the graduate teaching staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Financing Agriculture.** Capital and credit needs of farmers; agencies supplying credit; problems of borrowers and lenders. ¾ or 1 unit. Prerequisite: Economics 102 and 103, or 108. BAKER.

303. **Agricultural Law.** Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. ½ unit. HANNAH, KRAUSZ.

305. **Agricultural Policies and Programs.** The problems of agriculture as an industry and an analysis of past and current federal and state governmental policies and programs affecting agriculture; objectives and development of policies; the use of economic concepts in evaluating possible future agricultural poli-

cies and programs; and forces in policy formation. Field trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite; Economics 108. SPITZE.

312. **Farm Appraisals.** Same as Agronomy 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. REISS, STAFF.

318. **Land Economics.** Physical, economic, and institutional factors that affect the role of land in economic life; population and resource requirements; principles of land utilization; returns from land; land value; property rights and tenure rights; social controls; rural and urban land development. ¾ or 1 unit. Prerequisite: Consent of instructor. DOVRING.

324. **Farm Operation.** Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. VAN ARSDALL, WILLS.

325. **Advanced Farm Management.** The functions of management; effects of goals and values on management decisions; use of economic analysis in farm production planning including resource allocation and valuation, and cost minimization. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. HEADLEY.

326. **Professional Farm Management.** Principles of farm management applied to the problems of those managing farms for others as a profession; development of the profession; relationships with clients and farm operators; division of inputs and returns between owner and operator; direct operation of farms with hired labor; case problems; business practices and procedures; professional ethics. Field trips to farms and professional farm management offices; estimated expense, $15.00. ¾ or 1 unit. Prerequisite: Credit or registration in Agricultural Economics 324; Agricultural Economics 325. HOLCOMB.

331. **Grain Marketing.** Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially futures markets; inventory management, operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or Marketing 101. HIERONYMUS.

332. **Livestock Marketing.** Same as Animal Science 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. BROADBENT.

334. **Marketing of Dairy Products.** Same as Dairy Science 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or Marketing 101 or twelve hours of dairy science or dairy technology. BARTLETT.

335. **Economics of Food Distribution.** Same as Horticulture 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. KELLY.

337. **Economic History of American Agriculture.** Same as Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. SCHWEITZER.

341. **Agricultural Statistics.** Statistical methods applied to agricultural economics including graphic presentation, frequency distribution, inference and probability, time series analysis, index numbers, analysis of variance, regression, and correlation. ½ unit. WEST.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. ¾ or 1 unit. Prerequisite: Economics 102 and 103, or 108. BRINEGAR, SCHMIDT.

370. **Family Economics.** Same as Home Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

Rural Sociology

COURSES FOR GRADUATES

407. **Population Studies and Demographic Analysis.** Same as Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections; relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

477. **Rural Community Organization and Development.** Same as Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of rural community organization; the process of community development as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117. LINDSTROM.

487. **Special Problems in Rural Sociology.** Same as Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

370. **Population and Social Ecology.** Same as Sociology 370. Growth and trends in world population; an intensive analysis of growth components, spatial distribution, compositional characteristics, and trends in United States population. Stress is placed upon social and economical characteristics of the population and the utility and implications these have for students of social science. ¾ or 1 unit. Prerequisite: Sociology 185 or equivalent. FOLSE.

AGRICULTURAL EDUCATION

This program leads to the Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational ag-

riculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of vocational agriculture, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Educational Psychology 311 and 312 and two of the following courses: History and Philosophy of Education 301, 302, 303, 304. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall, Professor Lloyd J. Phipps, 357a Education Building, and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

The Department of Agricultural Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees with a major in agricultural engineering. The student may specialize in field power and machinery (soil dynamics, tillage and earthmoving, operations analysis, dynamics of particles and mechanisms, accelerated drying, and vehicle stability); soil and water mechanics (hydraulics of structures, agricultural hydrology, drainage, mechanics of erosion, and water resources planning); farm structures (structural analysis and design, environmental control, air contaminates, and waste disposal); or electric power and processing (system analysis for farmstead mechanization, crop processing, and physical properties of agricultural products).

The grade-point average required for admission to graduate study is 4.0 for the last sixty hours of undergraduate work; however, applications of those with averages below 4.0 but above 3.75 are reviewed individually by the departmental graduate committee and admission may be recommended if credientials are satisfactory.

Candidates for the master's degree must have the equivalent of the undergraduate curriculum at the University of Illinois.

Candidates for the Doctor of Philosophy shall fulfill all the standard requirements of the Graduate College as noted on pages 23 to 25. The program provides for a major in agricultural engineering with a minor in other graduate departments of engineering, mathematics, physics, including soil physics, or other disciplines in the physical sciences.

Opportunity for independent study and research is an important part of both the Master of Science and the doctorate programs. Research opportunities are available in both the Agricultural and Engineering Experiment Stations. For the master's degree, a thesis involving an analytical or experimental investigation and satisfying about one-fourth of the credit for the program is normally required.

Inquiries concerning graduate work should be directed to Frank B. Lanham, Head of the Department, 245 Agricultural Engineering Building.

GRADUATE FACULTY

Professors: F. B. Lanham (Head of Department), H. H. Beaty, E. L. Hansen, R. C. Hay, B. A. Jones, Jr., J. W. Matthews, J. A. Weber, R. R. Yoerger.

Associate Professors: W. Bowers, B. J. Butler, J. O. Curtis, D. R. Hunt, E. F. Olver, G. C. Shove.

Assistant Professors: H. P. Bateman, D. R. Daum, R. F. Espenschied, R. N. Fenzel.

COURSES FOR GRADUATES

400. Research Orientation. Discussion of the philosophy and methods of research, thesis preparation, and publication of research findings. No credit.

436. Dynamics of Farm Machine Elements. Advanced study of the dynamics of farm machine elements with specific reference to functional operation, stresses, and fatigue life. 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. Yoerger.

446. Farm Tractors. A study of research findings that apply to farm tractors including tests of tractors and component parts, evaluation of transmission designs, travel efficiency, tractor stability and horsepower hour requirements for farm tractor operations. 1 unit. Prerequisite: Agricultural Engineering 346 or equivalent. Weber.

490. Seminar. Presentation and discussion of current research and literature in agricultural engineering. ¼ unit.

496. Problems in Agricultural Engineering. Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. 1 unit. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 1 to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. An agricultural problem with engineering implications is selected for study, investigation, and report wherein a satisfactory solution does not require a background in engineering education. For non-engineering students only. ½ unit. Prerequisite: Minimum grade-point average of 3.5; consent of instructor and head of department. Specific approval of the associate dean in advance of registration is required for a second special problems course. Staff.

331. Farm Machinery Technology. Application, functional operation and management of tillage, planting, chemical application and harvesting machinery incorporating current engineering, agronomic and biological research results. For students presently in or preparing for teacher training or extension education. ¾ unit. Prerequisite: Agricultural Engineering 112 or 221. Yoerger.

336. Design of Agricultural Machinery. Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. ½ unit. Prerequisite: Mechanical Engineering 224. Hunt.

346. Tractors and Prime Movers. Engineering aspects of design and application of tractors for farm, construction, and military use. Thermodynamics of engines, turbines, and other power units. Measurement of power and efficiencies, transmission of power, traction, stability, and hydraulic circuity. ¾ unit. Prerequisite: Mechanical Engineering 209, Agricultural Engineering 146, or equivalent. Weber.

356. **Soil Conservation Structures.** Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops, and practices in soil conservation and flood control. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235; Agricultural Engineering 277 or equivalent. JONES.

357. **Land Drainage.** The design, construction, performance, and maintenance of surface tile and open ditch drainage systems. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235. JONES.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ½ unit. HANSEN.

376. **Advanced Design of Farm Structures.** Timber, steel, and concrete building design, with emphasis on structures for agricultural production. ½ unit. Prerequisite: Civil Engineering 262; Agricultural Engineering 277 or equivalent. CURTIS.

381. **Electro-Mechanical Agricultural Systems.** Application of electric power and mechanical equipment to livestock production, crop conditioning, and materials handling systems for efficient use of time, power, and labor. Principles of planning materials handling systems; requirements for environmental control in agricultural production; electric controls circuits; and factors affecting drying, cooling, and processing of crops. ¾ unit. Prerequisite: Agricultural Engineering 281 or graduate standing in agriculture. BEATY.

387. **Agricultural Process Engineering.** Principles, design factors, equipment, and controls of systems for drying, refrigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. ½ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. SHOVE.

396. **Special Problems.** An agricultural problem is selected for study, investigation, and report wherein a satisfactory solution requires a strong background in engineering education. ½ unit. Prerequisite: Senior standing in engineering. STAFF.

AGRONOMY

The Department of Agronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop production, biometry, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis, morphology and classification, management, physical and colloidal chemistry, physical edaphology, physics.

The student must show promise of achievement in his chosen field, must have a grade-point average of 3.75 or higher for the last sixty semester hours of work completed, and must be approved by the Department of Agronomy. For students having grade-point averages below 4.0 but above 3.75, only those having unusually strong training in the basic sciences are considered for admission.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, microbiology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A pamphlet giving specific prerequisites and requirements may be obtained from the head of the Department of Agronomy.

A candidate for the Master of Science must present an acceptable thesis unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy.

GRADUATE FACULTY

Professors: M. D. Thorne (Head of Department), S. R. Aldrich, D. E. Alexander, A. H. Beavers, A. W. Burger, E. B. Earley, J. W. Gerdemann, J. E. Gieseking, H. H. Hadley, R. H. Hageman, J. B. Hanson, C. N. Hittle, A. L. Hooker, J. A. Jackobs, R. W. Jugenheimer, A. Klute, L. T. Kurtz, J. R. Laughnan, E. R. Leng, S. W. Melsted, R. T. Odell, M. B. Russell, W. O. Scott, F. W. Slife, F. J. Stevenson, E. H. Tyner.

Associate Professors: C. M. Brown, J. B. Fehrenbacher, R. W. Howell, J. W. Pendleton, D. B. Peters, B. R. Sabey, R. D. Seif, R. O. Weibel.

Assistant Professors: S. G. Carmer, R. L. Jones, E. B. Patterson, E. C. A. Runge, C. M. Wilson, J. T. Woolley.

COURSES FOR GRADUATES

400. Seminar. Discussions of current literature in crops and soils. Required of all graduate majors in agronomy. No credit. Staff.

402. Chemical Properties of Soils: Their Relations to Soil Development and Plant Growth. Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. 1 unit. Prerequisite: Agronomy 101 and Chemistry 101, 105, and 122, or equivalent. Melsted.

403. Genesis, Morphology, and Classification of Soils. Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions; classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Agronomy 301 or consent of instructor. Fehrenbacher.

405. Colloidal Chemistry of Soils. Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Gieseking.

411. Soil Physics. The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Klute.

412. Soil Organic Matter. Basic considerations in organic matter transformation; geochemistry of organic matter; nature and origin of humic substances; reactions of organic matter in soils and sediments. Lectures, discussions, and assigned readings. Offered in 1965-1966 and in alternate years. 1 unit. Prerequisite: Agronomy 309 or consent of instructor. Stevenson.

422. Pasture, Range, and Soil Conservation Research. Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. 1 unit. Prerequisite: Agronomy 121, 321, or 322. Jackobs.

423. Theory and Analysis of Plant Breeding Problems. Genetics of crop plants; problems in selection and hybridization. 1 unit. Staff.

424. Mineral Nutrition of Plants. Same as Botany and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions

and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

426. **Regulation of Plant Growth by Applied Chemicals.** A study of various chemicals used to inhibit or promote plant growth; their absorption, translocation, and mode of action; principles involved in their use and control. 1 unit. Prerequisite: Botany 230 and Chemistry 350, or equivalent. HANSON.

429. **The Evolution of Agricultural Economies.** Same as Anthropology and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. ALEXANDER, STAFF.

440. **Design and Analysis of Biological Experiments, I.** Same as Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. CARMER.

441. **Design and Analysis of Biological Experiments, II.** Same as Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Agronomy 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Agronomy 440 or equivalent. CARMER.

499. **Thesis Research.** 0 to 4 units.
(a) **Soils.** ALDRICH, BEAVERS, FEHRENBACHER, GIESEKING, JONES, KLUTE, KURTZ, MELSTED, ODELL, PETERS, RUNGE, RUSSELL, SABEY, STEVENSON, THORNE, TYNER.
(b) **Crops.** ALEXANDER, BROWN, BURGER, CARMER, EARLEY, GERDEMANN, HADLEY, HAGEMAN, HANSON, HITTLE, HOOKER, HOWELL, JACKOBS, LAUGHNAN, LENG, PATTERSON, PENDELTON, SCOTT, SEIF, SLIFE, WEIBEL, WILSON, WOOLLEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Special Problems.** Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit for this course. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

301. **Soil Survey with Emphasis on Illinois Soils.** Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois and the cause of these soil differences; the influences of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative soils. Field trips; estimated expense, $10.00. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. ODELL.

303. **Soil Fertility.** Influence of chemical and microbiological properties of soils on crop production; rhizobial fixation and other fertility effects of crop sequence; fertilizer needs, sources, materials, and applications. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. KURTZ.

304. **Soil Management and Conservation.** Influence of physical properties of soils on crop production; roles of drainage, tillage, crop sequence, and soil characteristics in land management. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. HINESLY.

309. **Intermediate Soil Science, I.** This course with Agronomy 310 is a science-based treatment of soil genesis, organic matter, microbiology, mineralogy, physics, edaphology, water relations, and chemistry. Students taking this course do not receive credit for Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Chemistry 122 and 133; Physics 101 and 102; Botany 100, 230, and 231; Geology 105; Microbiology 100 and 101; credit or registration in Mathematics 132 or 133. MELSTED, STAFF.

310. **Intermediate Soil Science, II.** Continuation of Agronomy 309. Students taking this course do not receive credit for Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Chemistry 122 and 133; Physics 101 and 102; Botany 100, 230, and 231; Geology 105; Microbiology 100 and 101; credit or registration in Mathematics 132 or 133. MELSTED, STAFF.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent.

321. **Ecological and Physiological Factors Affecting Crop Production.** The environmental requirements of crop plants and their physiological bases; the adequacy of the environment provided by crop land in the United States as a function of management, soils, and climate; and distribution and yield of selected crops as a function of environment. ¾ unit. Prerequisite: Botany 100; Chemistry 132 or 133. HANSON.

322. **Forage Crops and Pastures.** Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. ½ unit. Prerequisite: Agronomy 121. JACKOBS.

323. **Principles of Plant Breeding.** Same as Horticulture 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, and the maintenance of high quality seed stocks. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. STAFF.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. Field trip; estimated expense, $5.00. ½ unit. Prerequisite: Agronomy 121. SLIFE.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Mathematics 365. A study of methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Students are expected to solve problems on the computers. 1 unit. Prerequisite: Mathematics 295 and a course in statistics or statistical methods or equivalent, or consent of instructor. CARMER.

377. **Diseases of Field Crops.** Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. Offered in 1965-1966 and in alternate years. ½ unit. Prerequisite: Agronomy 204 or Plant Pathology 301. HOOKER.

ANIMAL SCIENCE

(Including Animal Nutrition)

The Department of Animal Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Animal Science. Research may be pursued in the following areas of specialization: (1) population and immunogenetics, (2) physiology of reproduction including endocrinology, (3) animal nutrition, (4) nutritional biochemistry, and (5) meats technology. In addition, a student who expects to terminate the graduate program at the master's level may pursue work in animal production. Beef cattle, poultry, sheep, swine, and a wide variety of laboratory animals are available for use in conducting research in the above areas.

The minimum grade-point average for admission to graduate study in animal science is 4.0. Applications of students with grade-point averages below 4.0 but over 3.75 are considered on an individual basis.

Courses in biological and physical sciences and mathematics are essential preparation for graduate work in any specialized area of animal science. Candidates specializing in the areas of animal nutrition or nutritional biochemistry must have training equivalent to one five-hour course each in quantitative analysis and organic chemistry; a course in physical chemistry also is strongly recommended. Candidates specializing in meats technology should have undergraduate training in meat evaluation, use, and/or processing, and in microbiology. Students lacking adequate background to register in graduate courses at the University of Illinois are expected to remove course deficiencies during the first year of graduate study.

GRADUATE FACULTY

Professors: R. O. Nesheim (Head of Department), D. E. Becker, R. M. Forbes, U. S. Garrigus, B. C. Johnson, J. Kastelic, A. V. Nalbandov, H. W. Norton, R. F. Nystrom, H. M. Scott, R. J. Webb.

Associate Professors: B. C. Breidenstein, H. H. Draper, P. J. Dziuk, E. E. Hatfield, A. H. Jensen, J. M. Lewis, S. P. Mistry, B. A. Rasmusen.

Assistant Professors: W. W. Albert, G. S. Smith.

Animal Science

COURSES FOR GRADUATES

400. **Seminar.** A review of current literature in the science of animal production. ¼ unit. Prerequisite: Consent of instructor. Staff.

401. **Principles of Beef Production.** A critical study of the objectives, design, and results of beef cattle experiments. 1 unit. Prerequisite: Consent of instructor. Garrigus.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. ½ unit. Prerequisite: Consent of instructor. Garrigus.

403. **Principles of Swine Production.** A critical study and interpretation of experiments in swine feeding, breeding, and management. Intended to aid in preparing students for positions in colleges, experiment stations, and related fields. ½ unit. Prerequisite: Consent of instructor. Becker.

404. **Principles of Poultry Production.** A discussion of research methods and findings in the field of poultry science, with some consideration of current industry problems. ½ unit. Prerequisite: Consent of instructor. Scott.

405. **Advanced Animal Genetics.** Genetic theory, analysis of animal breeding problems, genetic results of selection, and different systems of breeding. 1 unit. Prerequisite: Animal Science 305 or equivalent. Norton.

406. **Physiology of Reproduction.** Same as Zoology 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. NALBANDOV.

407. **Laboratory Methods in Animal Genetics.** ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NORTON.

408. **Laboratory Methods in Physiology of Reproduction.** Same as Zoology 408. ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NALBANDOV.

410. **Research Methods in Animal Science.** Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. ¼ to 1 unit; may be repeated for credit not to exceed a total of 1 unit. Prerequisite: Consent of instructor. BECKER, BREIDENSTEIN, GARRIGUS, SCOTT, STAFF.

411. **Population Genetics and Animal Breeding.** Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. **Advanced Endocrinology.** Same as Dairy Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. ½ unit; may be repeated for credit not to exceed a total of two units. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. CARMER.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Animal Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Animal Science 440 or equivalent. CARMER.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Beef Production.** The principles of feeding and management of beef cattle; financial aspects of beef production; diseases, parasites, and breeding difficulties of beef cattle. Lectures, demonstrations, and discussions. ¾ unit. Prerequisite: Animal Science 220 or equivalent. ALBERT.

302. **Sheep Production.** The sheep and wool industries; principles and practices of various phases of production. ¾ unit. Prerequisite: Animal Science 220 or equivalent. GARRIGUS.

303. **Pork Production.** The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. ¾ unit. Prerequisite: Animal Science 220 or equivalent. BECKER, JENSEN.

304. **Poultry Management.** Application of scientific principles to the management of poultry. Undergraduate students may register for four hours credit with laboratory or for three hours credit without laboratory. ¾ unit. Prerequisite: Animal Science 220 or equivalent. SCOTT.

305. **Genetics and Animal Improvement.** Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improve-

ment. ¾ unit. Prerequisite: Animal Science 110 or equivalent. DeFries, Rasmusen, Touchberry.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit. Prerequisite: Zoology 104 and either Dairy Science 100 or Animal Science 100. Lodge.

332. **Livestock Marketing.** Same as Agricultural Economics 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip: estimated expense $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. Broadbent.

Animal Nutrition

COURSES FOR GRADUATES

402. **Proteins and Amino Acids in Nutrition.** Methods of nutrition evaluation of proteins; nutritional requirements for individual amino acids; metabolism of the amino acids and of proteins in various species. ½ unit. Prerequisite: Chemistry 350 and 355 or equivalent. Mistry.

404. **Carbohydrates, Lipids, and Energy in Animal Nutrition.** Basic principles of energy metabolism and their application to animal nutrition; caloric and noncaloric roles of carbohydrates and lipids in nutrition; influence of the rumen on energy utilization. ½ unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. Forbes.

406. **Mineral Elements in Nutrition.** Nutritional requirements for individual mineral elements; physiological function; metabolism in animals; conditions contributing to mineral deficiency diseases in animals. ½ unit. Prerequisite: Animal Nutrition 351; Chemistry 350 and 355. Forbes.

407. **Vitamins in Nutrition.** Naturally occurring and synthetic forms of the vitamins and their biological activity for laboratory and domestic animals; clinical tests for vitamin deficiencies; metabolic products formed by different animals; functional forms of the vitamins and reactions in which they are involved; antimetabolites used in experimental nutrition. ½ unit. Prerequisite: Chemistry 350 and 355 or equivalent. Draper, Mistry.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. Conrad, Nystrom.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. **Principles of Animal Nutrition.** Studies of nutrient requirements of animals; function and utilization of nutrients; evaluation of nutritional adequacy and status; nutritional deficiency diseases; feeding and dietary standards. ¾ unit. Prerequisite: Chemistry 350 and 355, or Chemistry 354. Staff.

ANTHROPOLOGY

The Department of Anthropology offers graduate work leading to the Master of Arts and Doctor of Philosophy. Course work is available in the main branches of cultural anthropology, including linguistics, and in physical anthropology. Special training is available in a number of world areas—South and Southeast Asia, Africa, Indonesia, Latin America, Russia, and Siberia. Among the fields in which the department has specialized are: processes of culture growth and change; urban anthropology; personality and culture; political anthropology; population genetics; ethnolinguistics; field research techniques. Departmental investigations in archaeology include the Southwest, the Midwest, South America, and the programs of the Illinois Archaeological Survey and Highway Salvage Archaeology in Illinois. Opportunities for field work in the various branches of anthropology are regularly provided. The University of Illinois is affiliated with the Museum of Northern Arizona, Flagstaff, as a cooperating institution; facilities of this museum are available to staff members and advanced students.

Applicants for admission as first-year graduate students must (1) fulfill the general requirements of the Graduate College, and (2) have a grade-point average of at least 3.75. A student who does not have an undergraduate major in anthropology or its equivalent may be permitted to register for graduate courses, but will be required to make up any deficiencies.

A detailed statement of requirements for higher degrees and additional information about departmental programs and policies is available on request.

The prerequisite for a graduate minor in anthropology is six semester hours of undergraduate credit in anthropology. A student intending to offer anthropology as a minor subject should consult with the head of the department.

GRADUATE FACULTY

Professors: J. B. Casagrande (Head of Department), O. Lewis, J. C. McGregor, D. B. Shimkin, J. H. Steward.

Associate Professor: E. M. Bruner.

Assistant Professors: D. W. Lathrap, F. K. Lehman, D. G. Metzger, J. F. Yegerlehner.

Instructors: C. J. Bareis, E. Giles, A. H. Jacobs, A. H. Rohn, Jr.

COURSES FOR GRADUATES

401. General Anthropology, I. A comprehensive survey of the various subfields of anthropology, with special reference to contemporary trends in theory and method: anthropology among the sciences, historical perspectives, human evolution and variation, the nature of culture, cultural evolution, the ecological approach, archaeology, linguistics. 1 unit. Prerequisite: Twelve hours of anthropology or consent of instructor.

402. General Anthropology, II. Continuation of Anthropology 401. Cultural typology, technology and economic organization, social structure, political organization, religion, art, personality and culture, processes of culture change, acculturation, applied anthropology, the logic of anthropological research, field methods. 1 unit. Prerequisite: Anthropology 401 or consent of instructor.

429. The Evolution of Agricultural Economies. Same as Agronomy and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. Lathrap, Staff.

450. **Seminar in Anthropology.** Analysis of selected topics of special interest in anthropology. 1 unit. Students may reregister in this course up to a total of two units. STAFF.

451. **Social Structure.** This course is intended to acquaint the student with the descriptive techniques and methods of structural and functional analysis currently employed by social anthropologists in the study of primitive social groups and their methods of operation. 1 unit. Prerequisite: Consent of instructor. STAFF.

452. **Research Problems in Archaeology.** Seminar oriented to current research problems in archaeology, designed to acquaint students with theoretical and methodological aspects of particular problems, and to develop a critical perspective of archaeological research. Course may be repeated for additional credit. 1 unit. Prerequisite: Consent of instructor. MCGREGOR.

453. **The Formal Analysis of Kinship Systems.** A survey of a variety of the world's systems of kinship, marriage, and family organization. Concentration on the distinctive properties of kinship systems as a species of social structure, on the formal apparatus for describing and understanding them and their functions, and on the theory of kinship that arises from the use of such formal apparatus. ½ or 1 unit. Prerequisite: Consent of instructor. LEHMAN.

460. **Theories and Methods in Anthropology.** A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. 1 unit. CASAGRANDE.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. 1 unit. Prerequisite: Consent of instructor. STEWARD.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. 1 unit. Prerequisite: Anthropology 461 or consent of instructor. STEWARD.

463. **Seminar on Field Methods and Research Designs in Cultural Anthropology.** Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and comparative studies on both the tribal and peasant levels are examined. 1 unit. Prerequisite: Consent of instructor. STAFF.

471. **Personality, Culture, and Society.** A seminar on selected topics in culture and personality. The emphasis varies from year to year; possible topics include the interrelationship between social systems and personality, national character studies, comparative education, cultural learning and transmission, the psychological concomitants of cultural change. 1 unit. Prerequisite: Consent of instructor. BRUNER.

489. **Readings in Anthropology.** Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interests of the student. ½ or 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. STAFF.

490. **Individual Topics in Anthropology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study are approved by the adviser and the staff member who supervises the work. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. Preparation of theses. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. Field Methods in Linguistics. Same as Linguistics 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. LEHMAN, YEGERLEHNER.

310. Advanced Field Methods in Linguistics. Same as Linguistics 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Anthropology 309 or equivalent. LEHMAN, YEGERLEHNER.

317. Languages of the World. Same as Linguistics 317. A survey of the main language families of the world from both genetic and typological points of view. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

320. Political Anthropology. The comparative and analytic study of the political systems of representative non-Western peoples. Attention is also paid to the transformations of native political institutions as consequences of colonialism and political modernization. ½ or 1 unit. Prerequisite: Anthropology 103. JACOBS.

340. Human Evolution and Race. Man's place in nature; the principles of biological evolution and genetics as exemplified by the fossil evidence for man's evolution and the existing races of man. 1 unit. Prerequisite: Anthropology 102 or consent of instructor. GILES.

350. Archaeology of South America. This course studies the peopling of the continent and the subsequent rise of agricultural economies. Emphasis is placed on the spectacular rise of civilization in the region of the Central Andes. ½ or 1 unit. Prerequisite: Anthropology 102 or consent of instructor. LATHRAP.

351. Archaeological Surveying and Primitive Settlement Patterns. Problems and methods of archaeological surveying; consideration of archaeological data and its relation to geographical and ecological factors for particular areas; problems of analysis and interpretation of data in terms of aboriginal settlement patterns using comparative data from ethnology and archaeology. Course includes laboratory work. ½ unit. Prerequisite: Consent of instructor.

352. Precolumbian Civilizations of Mesoamerica. The major civilizations of Mexico and Guatemala are studied. Emphasis is placed on the growth and ramification of the several major cultural traditions and on the kinds of evidence which are available as a basis for the study of the growth of political units and their interaction. ½ or 1 unit. Prerequisite: Anthropology 102 or consent of instructor. LATHRAP.

353. Southwestern Archaeology. A detailed study of one archaeological unit in the United States, covering the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

354. Field Techniques in Archaeology. Participation in archaeological excavation; techniques, methods, and procedures discussed and practiced in actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

355. Laboratory Techniques and Problems in Archaeology. Laboratory work in the field; studying, evaluating, and writing final reports on preceding field work. S; 1 unit. Credit may be received twice if the areas or problems con-

cerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

356. **Physical Anthropology.** The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, physiology, or introductory zoology. MCGREGOR.

357. **Midwestern Prehistory.** A detailed study of the midwestern archaeological area covering the broad cultures with regional variations considered chronologically and stressing their interrelationships. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. MCGREGOR.

360. **Peoples of Oceania.** A survey of the groups inhabiting the islands of the Pacific, including Australia. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

361. **Peoples and Cultures of Mexico and Guatemala.** A survey of the people and cultures of Middle America with special emphasis upon Mexico and Guatemala. This course begins by placing Middle America geographically, historically, and culturally within the broader Latin American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. LEWIS.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from archaeological and historical records as well as from contemporary ethnological studies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. STAFF.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. STAFF.

366. **Peoples of Southeast Asia and Indonesia.** The culture, history, economy, social system, political organization, and character structure of the peoples of Indonesia, Malaya, and the Philippines. Attention also is paid to contemporary economic and political problems of the newly independent nations seen from an anthropological perspective. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. BRUNER, LEHMAN.

367. **Cultures of Native Africa.** A survey of the native cultures of Africa with particular emphasis on the development of culture types and the patterns of behavior associated with them. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. JACOBS.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

369. **Introduction to Human Ecology.** Same as Geography, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology and one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Language, Culture, and Society.** Same as Communications and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

371. **Culture and Personality.** A cross-cultural comparative analysis and evaluation of current theories of culture and personality formation. The course is concerned with the socio-cultural matrix in which personality develops, as well as with the application of personality concepts, especially those derived from psychoanalytic theory, to the study of primitive and modern society. ½ or 1 unit. Prerequisite: An introductory course in anthropology, sociology, or psychology, or consent of instructor. BRUNER.

372. **The Anthropological Study of Art.** A review of the anthropological approach to art with emphasis on structural analysis and the relationship of the artist to his culture. Problems of stylistic development are considered within the framework of cultural dynamics, and a survey of the major art style areas outside the Western tradition and the Orient is included. ½ or 1 unit. Prerequisite: Three hours of anthropology or consent of instructor. LATHRAP.

373. **Human Development in Cross-Cultural Perspective.** Same as Psychology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, sociology, or psychology, or consent of instructor.

374. **Problems in Human Ecology.** Same as Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. JACOBS, STAFF.

375. **Peoples and Cultures of the Near and Middle East.** A general survey of the bionomy of the area, followed by a description and analysis of the cultural patterns and social systems of the major ethnolinguistic divisions—Semitic, Iranian, Turkic—and the interrelating function of Islam. Particular consideration given to language, folklore, belles-lettres, music, architecture, crafts, etc. from an anthropological standpoint. Thereafter, selected ethnographies are considered for comparative purposes. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

380. **Applied Anthropology.** The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in nonindustrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

381. **Russian Culture History and Ethnology.** Same as Geography 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. **Siberian Culture History and Ethnology.** Same as Geography 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural and urban design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles); advanced structural theory and design; building construction; history of architecture.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture is 3.75. Applicants with averages below 3.75 but above 3.5 will be considered on an individual basis. All applications for admission should be accompanied by samples of the applicant's work in structures and design.

Students are expected to follow one of the recommended area programs unless approval is obtained from the chairman of the department for a special program. A minimum of eight units is required for the master's degree.

GRADUATE FACULTY

Professors: G. S. KEITH (Chairman of Department), J. S. BAKER, L. J. BRIGHTBILL, E. A. CONNALLY, P. H. COY, G. GUEVREKIAN, H. L. HORNBEAK, R. A. JONES, A. K. LAING, D. B. LINDSAY, R. P. LINK, C. B. LOOKER, E. I. LOVE, J. G. REPLINGER, I. SCHOUSBOE, R. J. SMITH, S. J. Y. TANG, E. F. TOTH, A. R. WILLIAMS.

Associate Professors: G. T. CLAYTON, E. M. FARNHAM, J. H. SWING, H. C. YOUNG.

COURSES FOR GRADUATES

417. **Development of Contemporary Architectural Thought.** An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, van der Rohe, Viollet-le-Duc, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, Serlio, and Vitruvius. ½ unit. Prerequisite: Consent of instructor. LAING.

431. **Advanced Theory of Architecture.** A review of principles of architecture and urban design; factors in programming architectural requirements; design

development; analysis and criticism. ½ unit. Prerequisite: Consent of instructor. WILLIAMS.

432. **Seminar in Architectural Design.** The analysis and criticism of selected buildings. Individual reports and discussion. ½ unit. Prerequisite: Architecture 431 or consent of instructor. WILLIAMS.

435. **Advanced Architectural Design.** Advanced study of space relationships and other elements of architectural design from urban scale to that of individual buildings, including the integration of structural, mechanical, and interior design. Joint studies in urban design with graduate students in urban planning and landscape architecture. 2 units. Prerequisite: Bachelor's degree in architecture (general option) or consent of instructor. WILLIAMS.

452. **Advanced Theory and Design of Steel Structures.** Theory and design in bending, buckling, torsion, and combined stresses in beams and columns. Study in design and behavior of connections; composite constructions; light gage steel construction analysis. Design and economy of simple and complex building frames. 1 unit. Prerequisite: Architecture 348 or consent of instructor. SCHOUSBOE, TANG.

454. **Advanced Structural Design in Reinforced Concrete.** Critical review of the methods and specifications involved in the design and behavior for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way and flat-slab floor construction; columns and footings; torsion; ultimate theory of design; economy and continuity in building design. 1 unit. Prerequisite: Architecture 358 or consent of instructor. TANG.

481. **Advanced Building Construction.** Characteristics and relationships of the multiple components of the building industry: labor, general and specialty contracting, the manufacture and distribution of materials. finance, government, building ownership and operation. Building costs and cost analysis. Studies of selected building materials, products, and construction techniques. ½ unit. Prerequisite: Consent of instructor. CLAYTON.

491. **Special Problems in Architectural Construction.** Individual direction in the investigation of selected topics in building construction. ½ to 2 units. Prerequisite: Credit or registration in Architecture 481. CLAYTON.

493. **Special Problems in Structural Theory and Design.** Individual or group investigation and study in architectural engineering application. Research in economy and design in correlation with architectural, mechanical, and structural requirements. Options: foundation design; prestressed concrete design; plastic design in steel; structural planning; wood construction; architectural research laboratory. ½ to 4 units. Prerequisite: Consent of instructor. HORNBEAK, SCHOUSBOE, TANG, STAFF.

494. **Special Problems in Architectural Design.** Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. ½ to 2 units. Prerequisite: Architecture 435 or consent of instructor. WILLIAMS, VISITING CRITICS.

496. **Special Problems in Architectural History.** Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. ½ to 2 units. Prerequisite: Architecture 417 or consent of instructor. CONNALLY, LAING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Architectural Design.** Continued study of architectural design emphasizing (a) complex site development and composition, and (b) definitive design and refinement of detail for one of the plan components. Preparation of senior thesis program. 2 units. Prerequisite: Architecture 236. STAFF.

338. **Architectural Design.** Individual research and comprehensive design solution of a selected architectural project, with special emphasis on site development, integration of structures; mechanical equipment, illumination, and acoustics. 2 units. Prerequisite: Architecture 337. STAFF.

339. **Urban Housing.** Study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. ½ unit. Prerequisite: Consent of instructor. JONES.

347. **Theory of Structures.** Advanced problems in the analysis of statically determinate structures; general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. 1½ units. Prerequisite: Architecture 257 and Mathematics 142. HORNBEAK.

348. **Advanced Structures.** Advanced topics on design of structural members and connection. Analysis and design of continuous structures, rigid frames, and tall buildings. 1½ units. Prerequisite: Architecture 347; credit or registration in Architecture 358. COY.

358. **Advanced Reinforced Concrete.** Reinforced concrete building design. 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348. TANG.

ART

The Department of Art offers graduate work leading to the degrees listed below.

The prerequisite for graduate work leading to the master's degree is the Bachelor of Fine Arts as established at this University, with a concentration in the field to be pursued in graduate study, or its equivalent. For admission, an applicant must be a graduate of an accredited college or university, with at least a bachelor's degree, and with a grade-point average of 3.5 or above; he must be accepted by the graduate committee of the Department of Art after examination of his transcripts, as well as examples of his work, if his major is to be in a creative field. Students expecting to major in art education must have (or be eligible for) a teaching certificate in their field.

Normal residence requirement is two years for the Master of Fine Arts, and one year for the Master of Arts, although the graduate committee may extend this requirement or increase the unit requirements if this seems warranted.

Complete descriptions of offerings and admission requirements for all degrees, and instructions for applying for admission and grants may be had by writing for application forms and the brochure on Graduate Programs in Art, to Warren F. Doolittle, Graduate Programs in Art, Department of Art, 140 Fine Arts Building.

Master of Fine Arts with Design Major (Graphic Design or Industrial Design). Students must complete all the following courses for a minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, four to six units; art history (two courses elected from the group Art 308 through 325), one and one-half units; art electives (Art 332, 333, 341, 351, 383, 385, 392, 393, 394, 494, and art history), two or three units. A thesis is required.

Master of Fine Arts with Painting and Printmaking Major. Students must complete all the following courses for a minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 495, two to five units; Art 497, two to five units; art history (two courses selected from the group Art 308 through 325), one and one-half units; electives (Art 332, 341, 351, 392, 393, 394, 491, 494; art history

and/or other courses approved by the adviser), one and one-half to two and one-half units. A thesis is required.

Master of Arts with Art Education Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; art history (one course elected from the group Art 308 through 325), three-fourths unit; art electives, two and one-fourth units; Educational Psychology 311, one-half unit; Educational Psychology 312, one-half unit; Secondary and Continuing Education 456, one unit; two of the following: History and Philosophy of Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required.

Master of Arts with Art History Major. Students must complete all the following courses for a minimum of eight units: Art 341, one-half unit; Art 491, one to three units; Art 493, one unit; Art 494, one unit; art history (elected from the group Art 308 through 325), one and one-half to three units; electives, one or two units. A thesis is required.

GRADUATE FACULTY

Professors: J. R. Shipley (Head of Department), E. H. Betts, C. W. Briggs, L. R. Chesney, Jr., C. A. Dietemann, W. F. Doolittle, J. D. Hogan, J. W. Kennedy, R. Perlman, E. C. Rae, F. Roos, H. A. Schultz, M. A. Sprague, A. S. Weller, E. J. Zagorski, N. Ziroli.

Associate Professors: D. E. Frith, K. M. Lansing, Ann Perkins, R. von Neumann.

Assistant Professors: P. Bodnar, R. L. Majorowicz, E. C. Wicks.

COURSES FOR GRADUATES

450. **Studies in Modern Art.** Investigation of special problems; writings of artists and critics; preparation of critical reports. 1 unit. Prerequisite: Consent of instructor.

451. **Studies in American Art.** Investigation of special problems; historical development of the study of American art; techniques of conservation and restoration. 1 unit. Prerequisite: Consent of instructor.

467. **Graphic Design Laboratory.** Individually directed research in the studio with concentration in graphic design. 1 to 2 units. Prerequisite: Bachelor of Fine Arts in graphic or advertising design, or equivalent. Staff.

477. **Industrial Design Laboratory.** Individually directed research in the drafting room or workshop with concentration in industrial design. 1 to 2 units. Prerequisite: Bachelor of Fine Arts in industrial design or equivalent. Shipley.

491. **Special Problems.** Individual direction in research and in creative activity; thesis. ½ to 2 units. Staff.

493. **Seminar.** Introduction to methods of research and criticism. 1 unit. Roos.

494. **Studies in Art History and Criticism.** Individual study of special periods of art history; intensive reading of selected critical works; the writing of art criticism. 1 unit. Prerequisite: Graduate standing in art; graduate standing in other departments with consent of departmental graduate committee. Rae, Roos, Weller.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. ½ to 2 units. Staff.

496. **Sculpture Laboratory.** Experience at a professional level in sculptural techniques including metals casting, welding, stone carving, wood carving, clay modeling, and ceramic sculpture, with emphasis on the development of cre-

ative achievement. 1 to 3 units. Prerequisite: Graduate standing in art and permission of the departmental graduate committee.

497. **Print Workshop.** Intaglio printing, including etching, engraving, and aquatint. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Early Medieval Art.** The arts of Byzantium and of Western Europe from the early Christian through the Romanesque period. ¾ unit. Prerequisite: One year of history of art.

309. **Gothic Art.** The arts of Western Europe from the end of the Romanesque period until the Renaissance. ¾ unit. Prerequisite: One year of history of art.

310. **The History of Printmaking.** The development of the various graphic processes in the hands of important printmakers from the fifteenth through the nineteenth centuries. ½ or ¾ unit. Prerequisite: One year of history of art; consent of instructor.

311. **Classical Art.** Architecture, painting, sculpture, and minor arts of Greece and other ancient civilizations of the Mediterranean area. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany. Spain, and England. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

318. **Latin American Art.** Study of the more important phases and periods of the visual arts of Latin America. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

319. **Italian Art of the Seventeenth and Eighteenth Centuries.** An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

320. **Northern European Art of the Seventeenth and Eighteenth Centuries.** An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, and England during the seventeenth and eighteenth centuries, in terms of major figures and dominant stylistic developments. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

321. **Twentieth-Century Art: 1900-1925.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

322. **Twentieth-Century Art: 1925 to Date.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

323. **American Art to 1840.** Architecture, painting, sculpture, and minor arts of the Colonies and the United States to 1840. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

324. American Art, 1840 to 1900. Architecture, painting, sculpture, and minor arts of the United States. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

325. Recent American Painting and Sculpture. Current developments, with special emphasis on works shown in contemporary exhibitions at the Krannert Art Museum. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

332. Drawing. Advanced drawing in several media. ½ to 1 unit. Prerequisite: Art 126 or equivalent; for graduates, consent of departmental graduate committee. STAFF.

333. Painting. Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts in painting and printmaking. ½ to 1 unit; may be repeated for a total of 2 units. Prerequisite: Art 142 or equivalent; for graduates, consent of departmental graduate committee. STAFF.

341. Painting Materials and Techniques. Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. ½ unit. Prerequisite: Art 142 or graduate standing in art.

351. Advanced Sculpture Techniques. Advanced work in various sculptural media. ½ to 1 unit. Prerequisite: Art 252 or equivalent.

383. Print Media. Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts in painting. ½ to 1 unit. Prerequisite: Art 284 or equivalent; for graduate students, consent of departmental graduate committee.

385. Lithography. Laboratory course in lithography. Course of study includes a complete development of the process, exploiting its potential as a fine art medium. ½ to 1 unit. Prerequisite: Art 286; consent of departmental graduate committee.

392. Silversmithing, I. Advanced course in design and execution of hollow ware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. ½ to 1 unit. Prerequisite: Consent of instructor.

393. Silversmithing, II. Advanced course in design and execution of flatware and hollow ware, dealing primarily with forging and seaming methods, engraving, and toolmaking. ½ to 1 unit. Prerequisite: Consent of instructor.

394. Ceramic Design. Ceramic design with emphasis on the development of professional style and personal expression. ½ to 2 units. Prerequisite: Art 295 or consent of instructor.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Astronomy (including radio astronomy). Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. In addition, the normal entrance requirements are as follows: (1) a bachelor's degree in astronomy, physics, electrical engineering, or mathematics; and (2) a one-year course in descriptive astronomy.

The eight units for the Master of Science may be obtained in three ways, listed as (1), (2), and (3) below. Alternative (3) is intended for students wishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be at the 400 level.

(2) Two units may be selected from approved courses in mathematics; two units may be taken in approved courses in physics; the remaining units must be taken in astronomy. At least three units must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be secured by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the Doctor of Philosophy may be obtained by writing to the head of the department, University of Illinois Observatory, Urbana, Illinois.

For information regarding applied mathematics, see page 252.

GRADUATE FACULTY

Professors: G. C. McVittie (Head of Department), G. W. Swenson, Jr., S. P. Wyatt, Jr., K. M. Yoss.

Assistant Professors: J. R. Dickel, J. B. Kaler.

COURSES FOR GRADUATES

401. **Stellar Atmospheres.** Physical characteristics of stellar atmospheres as derived from spectroscopic observations; radiation transfer, theory and observations of the continuous spectrum, limb darkening; formation of absorption lines, line profiles, curves of growth, relative chemical abundances; emission features; forbidden radiation. 1 unit. Prerequisite: Consent of instructor. Kaler.

403. **Gaseous Nebulae and the Interstellar Medium.** Distribution, structure, and spectra of nebulae; physical processes in planetary and diffuse nebulae; recombination, fluorescence, and forbidden line radiation; determination of physical parameters; nature of the interstellar medium; interstellar gas and grains; observation of interstellar medium. 1 unit. Prerequisite: Astronomy 301. Kaler.

404. **Theory of Stellar Structure.** Masses, luminosities, radii, and surface temperatures of stars; basic equations and stability conditions; nuclear reactions; integration of basic equations; results—initial stages, later stages, white dwarfs. 1 unit. Prerequisite: Consent of instructor.

415. **Experimental Methods in Radio Astronomy.** Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. 1 unit; may be taken a second time for credit. Prerequisite: Consent of instructor. Dickel, Swenson.

424. **Relativity and Cosmology.** Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

433. **Solar System Astrophysics.** Planetary orbits and perturbations; physical perturbations; physical parameters of the planets; planetary interiors, atmospheres, magnetospheres, and surface layers. The satellites. Asteroids and comets. Meteors, meteorites, and tektites. Interplanetary grains and gas. Problems of origin and evolution. 1 unit. Prerequisite: Consent of instructor. Dickel, Wyatt.

486. **Constitution of the Ionosphere: An Introduction to Aeronomy.** Same as Electrical Engineering 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent. Bowhill.

491. **Seminar in Special Topics.** 1 to 4 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introductory Astrophysics.** Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors; special types of stars, interstellar matter. 1 unit. Prerequisite: Physics 108. KALER.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Aeronautical and Astronautical Engineering 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE.

307. **Celestial Mechanics.** Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. 1 unit. Prerequisite: Astronomy 306 or Physics 322. MCVITTIE.

314. **Observational Astronomy.** Same as Civil Engineering 305. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143. WYATT.

321. **Galactic Structure.** Observational data on the distribution of stars in space; stellar statistics; stars in solar neighborhood; space-density analyses; galactic rotation; stellar populations and their distributions; the form and content of galaxies. 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143. YOSS.

357. **Radio Astronomy.** Same as Electrical Engineering 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108. DICKEL.

366. **Aeronomy: Physics of the Upper Atmosphere and Space.** Same as Electrical Engineering and Physics 366. Structure and composition of the earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321, and 381; or consent of instructor. BOWHILL, RAETHER.

BIOCHEMISTRY

Biochemistry is a multidisciplinary field resulting from an interaction of chemistry and physics with biology. The biochemistry staff offers training in biochemistry, or molecular biology and biophysical chemistry (see pages 76 and 88). Programs leading to graduate degrees in biochemistry are offered in the Biochemistry Division of the Department of Chemistry and Chemical Engineering. Entering graduate students in biochemistry must therefore meet the graduate entrance requirements of the Chemistry Department (see page 87).

Interested students should contact the Biochemistry Division.

BIOLOGY

See descriptions and course listings under Life Sciences, page 215.

BIOPHYSICS AND BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

Biophysics is a rapidly growing field that cuts across many disciplines. An area overlapping with this and developing through interaction of chemistry and biology is that of biophysical chemistry.

Since graduate study in biophysics and biophysical chemistry involves several areas of biological and physical science, the Graduate College has adopted a flexible system enabling students to enter special interdisciplinary programs in these areas, thus affording them a wide range of opportunity for study and research in borderlands between the biological and physical sciences.

For the program leading to the Doctor of Philosophy in Biophysics see descriptions and course listings under Life Sciences, page 228.

Students majoring in chemistry or microbiology may elect to specialize in biological problems at the molecular level (see pages 88 and 224). Students in other areas of the biological and physical sciences who wish to arrange programs of study emphasizing biophysics should direct their inquiries to the head of the major department.

BOTANY

See descriptions and course listings under Life Sciences, page 217.

BUSINESS

The Doctor of Philosophy in Business is awarded to those who complete the subject matter requirements listed below and the general requirements outlined in the first section of this catalog. The subject matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by synchronization of courses previously taken with those offered in this program.

In lieu of the usual major and minor requirements for the doctorate, candidates for the Doctor of Philosophy in Business must prepare themselves for examination in five fields. Two of these, management and economic theory, are required, but the other three are elective. One of the elective fields may be outside the College of Commerce and Business Administration and must include at least two units. Within these requirements it is expected that each student will select, in consultation with his adviser, an individual program of study to meet his specific needs and objectives. For numbers and titles of courses available, see the listings in this catalog under accountancy, business education, economics, finance, industrial administration, and marketing.

Because the major fields for this degree cross departmental lines, administration of the work is supervised by a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the Chairman of the Committee on the Doctor of Philosophy Degree in Business, 350 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

499. Thesis Research. 0 to 4 units.

BUSINESS ADMINISTRATION

The Graduate School of Business Administration offers professional programs in business administration leading to the degrees of Master of Business Administration, Doctor of Business Administration, Master of Accounting Science, and Master of Commerce.

Master of Business Administration. The Master of Business Administration program is designed primarily for students whose undergraduate preparation is in liberal arts and sciences, engineering, or other nonbusiness areas. Students whose undergraduate preparation is in business may apply for admission, and the make-up of programs of those admitted is frequently adjusted to account for the special preparation of the degree candidate. The M.B.A. program requires a minimum of sixteen units (or sixty-four semester hours) of course work. No thesis is required. Candidates are admitted in September and February.

The first-year M.B.A. candidate normally is required to take the following courses: Business Administration 500, 501, 510, 511, 520, 531, 540, 541, 551, 560, 570 and 571 or 571 and 572. Second-year M.B.A. candidates are required to complete a two-semester sequence in each of the following: an environmental area, a functional area (marketing, production, finance, or international business operations), a quantitative area (mathematics, operations research, or advanced managerial accounting), and a behavioral area (behavioral theory of the firm, graduate work in psychology or sociology, labor and industrial relations). In addition, each second-year M.B.A. candidate is required to take Business Administration 544.

Doctor of Business Administration. Applicants for the Doctor of Business Administration program should have completed their master's program in the upper one-half of their master's class. A minimum of eight units of professional courses beyond the master's degree is required. Candidates who have earned a master's degree from one-year programs are required to complete a minimum of sixteen units of course work. Candidates are admitted in September, February, and June.

Upon completion of the course work, each candidate is required to take comprehensive examinations in the following areas: advanced economic analysis, one functional area, one behavioral area, one quantitative area, and business policy. A thesis which demonstrates the capacity to do independent research also is required.

Master of Commerce. The Master of Commerce program is designed specifically for students whose undergraduate preparation is in business. Candidates for the Master of Commerce degree are required to take an evaluation examination upon entering the program. This examination covers the equivalent of the first-year M.B.A. program. An outstanding performance on this examination permits granting of the Master of Commerce degree after completion of eight units of course work. Normally, a candidate who is well prepared in the several areas of business administration is required to complete twelve to fourteen units of work.

Master of Accounting Science. For details of this program, see Accountancy, page 42.

Additional information concerning the requirements of the various degree programs may be obtained from the Graduate School of Business Administration, 320 Commerce and Business Administration Building (West).

PROFESSIONAL COURSES

500. **Business Economics.** Analysis of supply and demand functions in an uncertain environment; practical applications of economics to the management of business enterprise; the firm's place in the economic system; the place of the enterprise in national accounts. Case materials are used. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

501. **Managerial Economics.** Monetary and national income analyses essential to understanding governmental policies directed to macro-economic goals; the impact of such policies on the individual business firm and on decision-making by business management; the responsibilities of the individual business firms in contributing to the attainment of social goals of a macro-economic nature; the role of the business leader in formulating public policy in the macro-economic area. ¾ unit. Prerequisite: Business Administration 500 or equivalent.

510. **Administrative Behavior.** This course focuses on the problems faced by an administrator in an interpersonal setting. Primary emphasis is on the analysis of individual and group behavior in a union and nonunion work setting and the determination of actions which the administrator can take to promote desired work performace. Extensive use is made of theory and research related to individual and group behavior to aid in the diagnosis of problems covered. Students take part in either laboratory or field studies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

511. **Business Organization.** An analysis of business organization. Major emphasis is on the processes of allocation, coordination, and communication, making decisions about organizations under conditions of certainty and uncertainty for optimal performance, and measures of organizational performance. Critical examination of factors involved in choosing either a centralized or a decentralized style of organization. ¾ unit. Prerequisite: Business Administration 510.

512. **Business Organization and Its Environment.** An analysis of business organizations adapting to shifts in internal and external elements. Major emphasis is on (1) the business firm as a part of a complex socio-economic system; (2) the effects of government, labor unions, and political, religious, and business organizations on the executive's decision problems; (3) environmental factors conducive to organizational change; and (4) organizational growth. ¾ unit. Prerequisite: Business Administration 511.

513. **Seminar in Organization Theory.** This course examines the major types of organization theory. Use of organization theory to guide research and to make business decision; examination of major research methods used to study business organizations. ¾ unit. Prerequisite: Business Administration 512.

520. **Marketing.** An introductory analysis of the marketing system, its operations, and the mechanisms for coordinating these operations. The relationships of the firm to other firms and other institutions in the marketing system are studied, and the effects that such relationships have on the nature of decision problems of the individual business are analyzed. The firm's problem in developing an integrated marketing program, and the specific problem areas of price, channel, location, sales, and market development are discussed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

522. **Quantitative Analysis for Marketing Decisions.** The development of analytic quantitative models of various aspects of the firm's marketing environment and of models of marketing decision problems is studied. The course also involves a study of the ways in which such models can be used as a basis for making marketing decisions. Topics include market measurement, estimation of various kinds of market data, identification of the relationships between marketing variables, and forecasting. ¾ unit. Prerequisite: Business Administration 520 or equivalent.

524. **Market Development.** Communication from manufacturers and middlemen to consumer and industrial users, and from manufacturers to middlemen, is an essential element in the marketing process. The course deals with management of the several components of the market communication function including personal selling, advertising, sales promotion, and some marketing aspects of public relations activities for both consumer and industrial goods. Management of the market communication function is studied through cases dealing with (1) determining market communications goals and policies; (2) creating an organization to perform the market communication function; (3) planning market communication operations, including problems such as planning a sales campaign, selecting advertising media, setting standards and coordinating advertising with personal selling, and dealer promotions; (4) stimulating personnel and controlling execution of the plans; and (5) evaluating results obtained from specific selling activities. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

525. **Product Management.** This course deals with the decisions on the firm's total market offer, including such topics as (1) use of market analysis in making decisions on assortment, product development, pricing, packaging, branding, and sales forecasting, and (2) coordination of these decisions and actions with market communications, physical movement, production, finance, and the over-all goals and policies of the firm. The use of analytic and research methods in making assortment and product decisions is emphasized. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

527. **Seminar in Marketing Theory and Policy.** This seminar is designed to study theories relating to the marketing system and the role of the individual business firm within that system. Marketing policy problems are discussed within the framework of various aspects of the firm's environmental circumstances. Marketing planning and decision-making processes covered include those involved in choice of policy concerning the marketing mix, price and product strategy, market development, and social and governmental relations. ¾ unit. Prerequisite: Business Administration 524 or 525.

531. **Introduction to Production.** An introductory course in decision-making problems in production. The course includes the theoretical foundations for production management as well as the applications of decision-making techniques to production problems in the firm. In particular, production processes, plant layout, maintenance, scheduling, quality control, and production control are considered. ¾ unit. Prerequisite: First semester of the M.B.A. program.

532. **Production Planning and Control.** Decision-making topics in production at the factory manager level and above are treated in depth. Topics include the development of generalized decision rules and systems analysis in production. In particular, the design of production control, quality control, and inventory control systems are stressed, and each of these systems is integrated into the firms as a whole. ¾ unit. Prerequisite: First year of the M.B.A. program.

533. **Quantitative Techniques in Production.** An advanced course in the application of quantitative techniques to decision-making problems dealing with production in the firm. Topics include structural estimation of production systems,

application of operations research techniques to production problems, and computer simulation of decision systems. ¾ unit. Prerequisite: Business Administration 532 or equivalent.

540. **Written Analysis, I.** To develop the student's ability in writing reports based upon analysis of cases and the conclusions reached, this course has a three-fold objective: (1) to improve the student's capacity to express himself effectively and efficiently in writing; (2) to contribute to the sharpening of his analytic skills; and (3) to help him integrate the knowledge learned in the functional fields. ½ unit. Prerequisite: Registration in the Graduate School of Business Administration.

541. **Written Analysis, II.** The first part of this course is devoted to the scientific method of inquiry and specific research techniques. The purpose is to study both elements of basic logic and research procedures in order to help the student evaluate the reliability of data and validity of conclusions contained in business reports. The second part of the course is devoted to a major field study. Each student develops a solution to a business problem and presents an oral and written report of the solution to both the faculty and the businessmen concerned. ½ unit. Prerequisite: Business Administration 540 or equivalent.

542. **Business and Society.** The position of the business enterprise as an institution in American society. The role of the businessman in that society. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

543. **Legal Problems of Business Management.** Past and current development of the legal climate in which business operates and in which managerial decisions are made; growth of the common law with its system of courts and procedure for law enforcement; the law of contracts, including various devices available for protection of creditors; legal problems involved in selecting a form of business organization. Students analyze business problems to see the importance of proper applications of the law to managerial decisions in regard to business policies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

544. **Executive Policies and Planning.** A course on policy construction at the executive level and the planning aspects of policy implementation. Builds a general management point of view. Study of company-wide situations from the vantage point of the chief executive. Case method study with supporting readings. Develops integration and application of the subject matter of prior courses. 1 unit. Prerequisite: Completion of first year of the M.B.A. program or equivalent.

545. **Business Logistics.** Movement, distribution, and control of raw materials and finished goods; site selection for manufacturing, warehousing, and distribution facilities; transportation media, selection, inventory control, communications networks, and requirements for logistics control data. Emphasis is on developing an integrated logistics system for a company. ¾ unit. Prerequisite: Enrollment in second year of the M.B.A. program or consent of instructor.

551. **Financial Analysis.** An introduction to the subject of managerial finance, with emphasis on basic decisions of management and provision of capital resources. Techniques of profit planning and forecasting, evaluation of financial performance relative to control standards, and development of criteria for commitment of funds are stressed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

552. **Financial Management and Control, I.** An analysis of the tools and techniques of capital expenditure management, with emphasis on the relation of financial forecasting and control to criteria for investment planning and asset management. The theory of investment is examined, as well as the relation of organi-

zational structure to capital planning policy. ¾ unit. Prerequisite: Business Administration 551.

553. **Financial Management and Control, II.** An analysis of the problems confronting corporate financial management in deciding appropriate methods of financing capital expenditure commitments. A thorough analysis of the specialized literature, coupled with the use of selected case material, forms the core of the course. ¾ unit. Prerequisite: Business Administration 552.

554. **Financial Theory and Policy.** Special problems of economic analysis and their relation to the functional discipline of managerial finance; includes study of techniques for forecasting financial requirements under uncertainty, problems of income determination, the relation of long-term capital commitments to uncertain payoff vectors, internal and external capital rationing, and problems of identifying capital supply functions. ¾ unit. Prerequisite: Business Administration 553, 573, and 576.

557. **Seminar in Finance.** Analysis of (1) financial policies and problems connected with corporate expansion through acquisition of interest in, or absorption of, established concerns, including an examination of the legal, economic, and financial background for business combination, or (2) specific problems of financial management in light of differing operating characteristics of major enterprise classifications, including opportunities for students to construct decision models for application to problems of financial management. ¾ unit. Prerequisite: Business Administration 554 and 573.

560. **Managerial Accounting and Control.** An analysis of managerial controls, the information needed for their operation, and the manner in which accounting provides that information; emphasis upon accounting as a tool of management. Problems and cases stress the type of figure information relevant to managerial decisions, and the methods of using such data. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

562. **Industrial Cost Control.** A study of cost accounting, with emphasis on the use of operating data by management for control purposes. Methods of material pricing, labor costs, including fringe benefits; indirect manufacturing costs, direct costing, standard costs; estimated and statistical costs; distribution costs; contribution to overhead theory; depreciation and replacement of equipment; selection of plant; decision to make or buy; relation betwen costs and pricing policy. ¾ unit. Prerequisite: Business Administration 560 or equivalent.

563. **Controllership.** The controller in the business organization: his property control responsibilities; internal check; internal audits; insurance; his assistance to operating management through budgeting, break-even analysis, profitability studies; his relationship with groups outside of management such as investors and government agencies; emphasis on manner in which figure function of controlled is used to integrate the operations of the business enterprise. ¾ unit. Prerequisite: Business Administration 562 or equivalent.

570. **Mathematical Analysis for Business Decisions.** The use of classical mathematics in business decision-making; development of the concepts of total and marginal value analysis. Special emphasis is placed on the construction of quantitative models of business and economic systems, topics in bivariate and multivariate functions, differentiations, and integration. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

571. **Decision Theory.** Application of finite mathematics to business decision-making; an introduction to the theory of sets; partitions and counting; vectors and matrices, as well as Bayesian statistics. Major emphasis is placed on linear programming and the theory of games. ¾ unit. Prerequisites: Registration in the Graduate School of Business Administration.

572. **Modern and Classical Statistics for Business Decisions.** The application of classical and modern statistics for business decision-making; topics in probability distributions, variance analysis, and partial and multiple correlation analysis as well as the use of personal probabilities and utility theory. ¾ unit. Prerequisite: Business Administration 571.

573. **Introduction to Operations Research.** An introduction to operations research techniques; topics in integer, nonlinear, and dynamic programming, queueing theory, replacement, and Monte Carlo techniques; special projects in game theory applications in business. ¾ unit. Prerequisite: Business Administration 572; completion of first year of the M.B.A. program.

574. **Application of Operations Research Techniques.** The application of the operations research techniques developed in Business Administration 573 to practical business problems. Most of the semester is devoted to a series of field research studies. Prior to the field studies, a review of previous work in the field is made. The role of the computer in solving operations research problems, as well as its application to the field research, is also a major consideration. ¾ unit. Prerequisite: Business Administration 573.

575. **Business Simulation.** An introduction to the use of computers in solving business problems. Topics include the relation of integrated data processing systems to information flows within the firm and the development of simulation models of intrafirm decision processes. ¾ unit. Prerequisite: Business Administration 573.

576. **Business Forecasting and Econometrics.** An introduction to maximum likelihood estimating techniques. Topics include the use and limitations of least squares, two-stage least squares, limited-information and full-information estimates. Problems with observational errors, multi-colinearity, and autocorrelation in time-series and cross-section structural estimation are considered. A major portion of the course is devoted to the application of the econometric techniques in business forecasting and analysis. ¾ unit. Prerequisite: Business Administration 572.

582. **International Business Operations, I.** An integration of economics and the functional areas of business focused on the problems of managing international business operations. Economic, legal, functional, and administrative problems are studied through cases and literature emphasizing financial and marketing problems. Students select one of Europe, Latin America, Africa, Middle and Near East, or South Asia and Far East, for special study and reporting. ¾ unit. Prerequisite: Completion of first year of the M.B.A. program.

583. **International Business Operations, II.** Continuation of Business Administration 582. ¾ unit. Prerequisite: Business Administration 582.

590. **Independent Study and Research.** Directed reading and research. ½ or 1 unit.

599. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

373. **Electronic Data Processing for Business.** A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general business is considered. The facilities of the Digital Computer Laboratory are utilized in the course. ½ or 1 unit. Prerequisite: Economics 170; Accountancy 106 or 108. HINOMOTO, URETSKY, STAFF.

BUSINESS EDUCATION

The Department of Business Education offers graduate work leading to the Master of Science in Commercial Teaching. The work is part of an integrated five-year program for those preparing to become commercial teachers. The requirements of the fifth year are based on the educational background of the first four years. Students may also take advanced degree programs in education, specializing in business education.

Students seeking admission in any area must have a grade-point average of 3.5. Only a limited number of the requirements listed below may be completed by extramural graduate study.

Candidates for the Master of Science in Commercial Teaching must earn three units in education, as described in (1) below; three units in commerce, consisting of two units from fields listed in (2) below and one unit from courses listed in (3) below (business education); and two units of electives. All courses must be selected with the approval of the student's adviser.

(1) Education. Three units consisting of Educational Psychology 311, 312, Vocational and Technical Education 456, and two of the following: History and Philosophy of Education 301, 302, 303, 304.

(2) Commerce (other than business education). Two units selected from accountancy, economics, industrial administration, and marketing.

(3) Commerce (business education). One unit selected from Business Education 351, 353, 361, 382, 383, 490, 499.

(4) Recommended electives. Two units selected from courses listed under (1) and (2), or not more than one unit from (3), or from courses in the following list: Secondary and Continuing Education 354, 439; Vocational and Technical Education 381, 459; Educational Psychology 390, 391, 411, 413, 422, 423, 425, 428; History and Philosophy of Education 401; and Educational Administration 460; Journalism 308. Other courses may be taken with the consent of the adviser.

The adviser for candidates for this degree is Professor Elizabeth R. Melson, 9 David Kinley Hall.

GRADUATE FACULTY

Professor: E. J. DeMaris (Acting Head of Department).

Associate Professor: Elizabeth R. Melson.

Assistant Professor: Mildred E. Reed.

COURSES FOR GRADUATES

490. Special Topics. Directed reading and research. ½ or 1 unit. No credit for students electing to write a thesis.

499. Thesis Research. ½ to 2 units.

Note: See also Secondary and Continuing Education 456 and 459.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. Improvement of Instruction in Shorthand. A study of the history, principles, and practices of shorthand instruction, including evaluation of literature, research, and methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every third semester and summer; ½ unit. Prerequisite: Sixteen hours in commerce, including Business Education 112; sixteen hours in education, including Educational Practice 242. Reed.

353. Improvement of Instruction in Bookkeeping. A study of the history, principles, and practices of bookkeeping instruction, including evaluation of

literature, research, and methods of teaching. Attention is given to the use of community resources, selection of students, testing, grading, job standards, and job adjustment. Every third semester and alternate summers; ½ unit. Prerequisite: Sixteen hours in commerce, including six hours in accountancy; sixteen hours in education, including Educational Practice 242. MELSON.

361. **Teaching Office Management and Machine Operations.** Designed for high school and college teachers. Selection and use of machines, course content for machine courses, and organization of instructional material. S; ½ unit. Prerequisite: Secondary and Continuing Education 241; Educational Practice 242; sixteen hours in commerce, six of which must be in accountancy; one year of teaching experience. MELSON.

382. **Organization and Administration of Cooperative Part-Time Programs in Business Education.** Deals with background, aims, coordination techniques, and administrative policies for organizing and operating cooperative part-time programs in distributive and office occupations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor.

383. **Problems in Cooperative Education.** Students apply for and secure distributive or office positions with selected cooperating business firms. While regularly employed in these supervised positions, they observe the relationships between those activities and the cooperative business education programs in the high school. These relationships are pointed up through regularly scheduled class meetings where emphasis is placed on job analysis, current trends, wage and benefit structure, personnel practices, and labor relations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers work leading to the Master of Science and Doctor of Philosophy in Ceramics or in Ceramic Engineering. The prerequisite for graduate study in these areas is proficiency in the undergraduate courses required for the Bachelor of Science in Ceramic Engineering at the University of Illinois, or acceptable equivalents.

A minimum grade-point average of 3.75 for the last sixty hours of undergraduate work is required for admission. Students with grade-point averages between 3.75 and 4.0 will be considered on an individual basis. Students who have bachelor's degrees in chemistry, physics, geology, or engineering may become candidates in this department, but they must make up any deficiencies in ceramics, which may include Ceramic Engineering 203, 204, 205, 206, 209, 214, 221, 222, and 310.

A candidate for the Master of Science in Ceramics or Ceramic Engineering must complete a minimum of eight units of graduate work including a thesis.

Candidates for the Doctor of Philosophy in Ceramics or Ceramic Engineering are required to pass the departmental qualifying examination. This must be taken no later than the last semester of the master's degree program, or no later than the first semester in residence for a student who has a master's degree from another department or university.

Candidates for the Doctor of Philosophy in Ceramics must present the equivalent of twenty-five semester hours of courses in inorganic, analytical, physical, and organic chemistry; calculus, including differential equations; one year of college physics; and a minimum of eighteen semester hours or equivalent in acceptable ceramics courses.

The most common minors selected by graduate students in ceramics or ce-

ramic engineering are chemistry, physics, mathematics, geology, or other engineering disciplines.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramics prerequisite.

GRADUATE FACULTY

Professors: A. L. Friedberg (Head of Department), A. W. Allen, R. L. Cook, F. V. Tooley.

Associate Professors: C. G. Bergeron, J. A. Nelson, V. J. Tennery.

COURSES FOR GRADUATES

401. **Ceramic Chemistry.** Silica, silicates, fusions, and phase relations. 1 unit. Prerequisite: Courses in chemistry and physics.

402. **Ceramics.** Chemical and physical phenomena. 1 to 2 units. Prerequisite: Courses in physics and chemistry.

405. **Glass Technology.** This course, following a brief review of unit processes and operations in glass manufacture, treats from a dominantly theoretical and research point of view selected major topics relating to the glass preparation process and the chemical, mechanical, optical, and electrical properties of glass. ¾ unit. Prerequisite: Ceramic Engineering 301 or equivalent, or consent of instructor. Tooley.

406. **Glass Technology.** This course is dominantly theoretical in approach. Following a survey of the basic theoretical ideas that have been used in the development of the glass model, student readings and reports from the classical and modern literature serve as the basis of class discussions on glass structure and behavior, with emphasis on structure property correlations. ¾ unit. Prerequisite: Ceramic Engineering 405 or consent of instructor. Tooley.

407. **Porcelain Enamels.** This course covers the fundamental scientific principles involved in the area of porcelain enameling and the properties of such coatings. 1 or 1½ units. (includes laboratory if taken for more than one unit). Prerequisite: Ceramic Engineering 222 and 320, or equivalent.

409. **Whitewares.** Advanced study in the field of whitewares, including fundamental considerations of glazes and all types of ceramic bodies. Special emphasis is placed on new developments in research and processing. Considerable attention is given to the ferroelectric and ferromagnetic properties of electronic ceramics. 1 or 1½ units (includes laboratory if taken for more than one unit). Prerequisite: Ceramic Engineering 209; Ceramic Engineering 340 or equivalent. Cook.

410. **Dielectric Properties of Ceramic Materials.** Fundamental properties of vector fields are reviewed. The reaction of insulating solids to external electric fields is considered in terms of dielectric theory. The properties of ceramic dielectrics including ferroelectrics are treated in terms of present theory. The piezoelectric properties of ferroelectric crystals and ceramics are correlated with the crystal structure, microstructure, and the ferroelectric properties. ¾ unit. Prerequisite: Mathematics 345 and 343, or consent of instructor. Tennery.

412. **Structural Physical Ceramics.** Structural chemistry and crystallization behavior of ceramic systems at elevated temperatures; nucleation, crystal growth; mineral synthesis; high-temperature reaction kinetics, including phase transformations and diffusion. ¾ unit.

421. **High-Temperature Technology.** A review of the methods of achieving and controlling high temperatures, both in industrial processes and in the laboratory, combined with a study of the techniques for measuring the properties

of materials at elevated temperatures emphasizing oxides, carbon and graphite, silicates, carbides, borides, silicides, nitrides, sulfides, cermets, and refractory metals. A correlation of the physical and chemical behavior of these materials with their crystal structure, microstructure, and physical form is emphasized where possible. ¾ unit. Prerequisite: Ceramic Engineering 310. ALLEN.

422. **High-Temperature Technology Laboratory.** Laboratory to accompany Ceramic Engineering 421, with emphasis on instrumentation for and measurement of properties at elevated temperature. Analytical interpretation of data in numerical problems is included. ½ unit. Prerequisite: Credit or registration in Ceramic Engineering 421, or consent of instructor. ALLEN.

461. **Mineralogy of Clays.** Same as Geology 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. **Mineralogy of Clays.** Same as Geology 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. GRIM.

495. **Materials and Special Problems.** Conference and laboratory. 0 to 2 units.

499. **Thesis Research.** Research in any of the branches of ceramics. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Glass Technology.** This course augments some of the subject matter of Ceramic Engineering 214, and develops additional subject matter relating to the theory of glass formation and structure and the behavior of glass as a function of composition, structure, and heat treatment. Students taking this course gain improved qualifications for research work in the field. ½ unit. Prerequisite: Ceramic Engineering 214 or consent of instructor. TOOLEY.

310. **Refractory Technology.** A study of the engineering properties and thermochemistry of polycrystalline materials for use at elevated temperatures, including processing of raw materials, the manufacture, heat treatment, quality control, and specification of refractory products. Particular emphasis is placed on oxides, silicates, carbides, borides, cermets, and refractory metals, with a correlation of the properties of those materials to certain design criteria. ¾ or 1 unit (includes laboratory if taken for one unit). Prerequisite: Senior standing in engineering. ALLEN.

320. **Advanced Porcelain Enamels.** An advanced study of the field of porcelain enamels with particular emphasis on fundamentals of bond or adherence of enamel metal systems, on opacity and mechanism of color development and measurement, and on the thermal and chemical properties of coatings on metal. Specific attention is given to coatings for use on metals at elevated temperatures. ½ unit. Prerequisite: Ceramic Engineering 222 or consent of instructor. COOK.

331. **Ceramic Microscopy.** A study of the optical activity in isotropic and anisotropic media with particular emphasis on the materials and products of ceramics; the application of these principles and related topics of optical microscopy to the study of the morphology, aggregation, size, and microstructure of the products of high-temperature thermochemical reactions and equilibria. ¾ or 1 unit (includes studies in thermal microscopy if taken for one unit). Prerequisite: Ceramic Engineering 205 and 206, or consent of instructor. ALLEN.

340. **Electrical Ceramics.** Special emphasis is given to the electrical properties and requirements of ceramics for use at normal and high frequencies. Fundamental structural consideration in the development of ferroelectric and ferromagnetic properties of ceramics is covered in considerable detail. Glass-to-metal and ceramic-to-metal seals, as well as ceramics for use in elevated temperature electrical circuitry, are presented. ½ unit. Prerequisite: Ceramic Engineering 209 or consent of instructor. TENNERY.

CHEMICAL PHYSICS

Fundamental research on many properties of molecular and solid state systems is based on an understanding of chemistry, physics, and mathematics that can best be obtained by training in more than one department of the University. A program leading to the Doctor of Philosophy in Chemical Physics makes it possible for students to gain the necessary background and perform original research in this interdisciplinary field of science.

Applicants for admission should have undergraduate degrees in chemistry or physics, a grade-point average of at least 4.0, and a strong background in the major field of chemistry or physics, with more than the usual training in the other area. Those who received their degrees in physics should have the equivalent of one semester each of organic and inorganic chemistry and one year of physical chemistry. Those who received their degrees in chemistry should have the equivalent of one semester each of intermediate mechanics and intermediate electricity and magnetism. One year of mathematics beyond calculus is recommended. Deficiencies should be removed during the first year of study.

In addition to satisfying the requirements of the Graduate College, students must pass either the qualifying examination in the Department of Physics or the set of cumulative examinations given by the Division of Physical Chemistry. A knowledge of the content of Chemistry 348 and 349 or Physics 362 and 381 must be demonstrated also (for example, by passing the final examinations in these courses).

The program of graduate study consists of courses in the areas of mathematics, physics, and chemistry. A one-year course in quantum mechanics must be included, and the other courses must be selected from the three areas with the approval of the Committee on Chemical Physics.

Research for the dissertation is performed under the direction of staff members who are currently active in chemical physics. Students may apply for fellowships and assistantships and may make use of the facilities available in the Departments of Chemistry and Chemical Engineering and Physics.

Students with undergraduate degrees in chemistry should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering; students with undergraduate degrees in physics should direct inquiries and applications to the head of the Department of Physics.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering. Attention is also called to a joint program leading to the Doctor of Philosophy in Chemical Physics (see above) and to the program in Biophysical Chemistry (see pages 76, 88, and 224).

Admission Requirements. Students at the University of Illinois who have fulfilled the usual undergraduate course requirements may apply for entrance to

the Graduate College in chemistry or chemical engineering if they have a grade-point average of 4.0.

Students who have completed graduate work in chemistry or chemical engineering and related subjects at another institution may be admitted, provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Students whose undergraduate records have not met the above requirements must have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution in order to be admitted to the Graduate College in chemistry or chemical engineering.

Students who are candidates for admission to the Graduate College in chemistry or chemical engineering must have had the equivalent of twenty-five semester hours in chemistry properly distributed.

Graduate students whose major subject is in some department other than chemistry and chemical engineering must have had the equivalent of fifteen semester hours in chemistry, including satisfactory work in general chemistry, qualitative and quantitative analysis, and elementary organic chemistry. Such students are advised to make selections from the following courses: Chemistry 315, 316, 321, 336, 337, 342, 343, 344, 345, 350, and 355. Courses of a more special nature are not, as a rule, accepted for graduate work unless preceded by one or more of the above courses.

Master of Science in the Teaching of Chemistry. Candidates for the Master of Science in the Teaching of Chemistry must meet the requirements for the Master of Science in Teaching of the Physical Sciences (page 282).

CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engineering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science must include two chemical engineering courses at the 400 level in their programs.

BIOCHEMISTRY

The Biochemistry Division of the Department of Chemistry and Chemical Engineering administers the graduate program in biochemistry. The curriculum is composed of Chemistry 350, 355, 450, 452, and 494 (same as Microbiology or Biophysical Chemistry 494), and selected offerings in allied chemical and biological areas. Interested students are invited to contact the biochemistry staff.

BIOPHYSICAL CHEMISTRY

The Department of Chemistry and Chemical Engineering, in collaboration with the Department of Microbiology, offers an area of specialization in biophysical chemistry. The program is flexible and provides the student with basic training in physical biochemistry and biology. Students electing this area should have a solid background in physics and mathematics. Details of the curriculum are decided individually. It is expected, however, that the student fulfill minor requirements in microbiology or some other biological science.

Courses in the Department of Chemistry and Chemical Engineering especially related to this curriculum are Chemistry 346, 452, and 494 (same as Microbiology 494). Related courses also are offered in the Department of Microbiology (Microbiology 330, 405) and in the Biophysical Division of the Department of Physiology and Biophysics (Biophysics 301, 401, 402, and 403).

GRADUATE FACULTY

Professors: H. E. Carter (Head of Department), H. A. Laitinen (Associate Head of Department), D. E. Applequist, J. C. Bailar, Jr., D. Y. Curtin, H. G. Drickamer, I. C. Gunsalus, H. S. Gutowsky, T. J. Hanratty, J. W. Hastings, N. J. Leonard, H. V. Malmstadt, R. A. Marcus, T. Moeller, R. F. Nystrom, K. L. Rinehart, W. J. Ruetter, G. A Sim, H. R. Snyder, S. Swann, Jr., K. E. Van Holde, G. Weber, J. W. Westwater, F. Wold, P. E. Yankwich.

Associate Professors: R. L. Belford, T. L. Brown, R. S. Drago, L. P. Hager, A. M. Hartley, J. P. Hummel, R. S. Juvet, J. C. Martin, T. S. Piper, J. A. Quinn.

Assistant Professors: J. E. Baldwin, P. Beak, V. A. Bloomfield, J. L. Brownlee, Jr., J. M. Clark, H. E. Conrad, W. H. Flygare, J. L. Hudson, J. G. Kay, I. C. Paul, C. E. Pfluger, W. H. Pirkle, R. L. Sani, R. A. Schmitz, G. J. Schroepfer, Jr., D. H. Secrest, S. G. Smith, G. D. Stucky, L. J. Todd, R. W. Woody.

Instructor: J. Goodisman.

Chemistry

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. 1 unit. Moeller.

404. **Advanced Inorganic Chemistry Laboratory.** Specialized laboratory techniques; more difficult inorganic syntheses. ¼ to ¾ unit. Prerequisite: Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. ¼ unit.

406. **Physical Inorganic Chemistry.** Qualitative description of the bonding in inorganic compounds; use of physical methods to provide information about the structure and reactions of inorganic compounds; structures and reactions of inorganic compounds in solution. 1 unit. Prerequisite: Chemistry 315 and 344.

407. **Special Topics in Inorganic Chemistry.** Discussions of newly developing areas of inorganic chemical research. ¼ to 1 unit. Prerequisite: Graduate standing in chemistry. Kay.

408. **The Chemistry of Complex Inorganic Compounds.** The nature of the coordinate bond; applications of complex compounds. 1 unit. Prerequisite: Chemistry 315.

421. **Spectrochemical Methods of Analysis.** Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree. Malmstadt.

422. **Electrical Methods of Chemical Analysis.** Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. 1 unit. Prerequisite: Chemistry 344 or equivalent. Laitinen.

423. **Electron Microscopy.** Same as Biology and Zoology 423. Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Open to qualified graduate students in all depart-

ments. ¼ unit. Prerequisite: Background of chemistry, physics, and mathematics. HALL.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods, and applications. ½ unit. HARTLEY, LAITINEN.

425. **Analytical Chemistry.** Seminar. Required of all graduate students whose major is analytical chemistry. ¼ unit. LAITINEN, STAFF.

426. **Applied X Rays.** Lectures. ¾ unit. Prerequisite: Training in physics and physical chemistry. PFLUGER.

427. **Applied X Rays: Crystallography.** Lectures. ¾ unit. Prerequisite: Training in physics and physical chemistry.

428. **Applied X Rays.** Laboratory. Training in operation of all types of x-ray apparatus with special emphasis on diffraction; experimental chemical identification and crystal structure analyses from powder and single crystal patterns. ¼ to 1 unit. Prerequisite: Credit or registration in Chemistry 426 or 427. PFLUGER.

429. **Electron Microscopy Laboratory.** Same as Biology and Zoology 429. Essentially individual instruction. Detailed training in operation and care of electron microscopes (four types); preparation of specimens including microtomy, electron staining, replication, and shadow casting; measurements and interpretations; special projects related to student's research interests. ½ or ¾ unit. Prerequisite: Graduate major in a biological science with adequate background in chemistry, physics, and mathematics; credit or registration in Chemistry 423; consent of instructor. HALL.

430. **Organic Chemistry.** Survey of organic chemistry for graduate students. 1 unit. Prerequisite: One year of organic chemistry.

431. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on reaction mechanisms and synthesis. 1 unit. Prerequisite: Chemistry 430 or 336 and one year of physical chemistry.

432. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on structure. 1 unit. Prerequisite: Chemistry 431 or 336.

433. **Organic Chemistry.** Special topics in organic chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as natural product synthesis and biosynthesis, organic photochemistry, chemistry of special families of organic compounds, etc. ½ or ¾ unit; ¾ unit requires two lectures per week. Students may repeat this course for credit. Prerequisite: Chemistry 431 and 432, one of which may be taken concurrently.

434. **Advanced Organic Synthesis.** Lecture and laboratory. ¼ to 1 unit.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. ½ unit. Prerequisite: Consent of instructor.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. 1 unit. Prerequisite: Consent of instructor.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and their molecular interpretation; determination and chemical use of thermodynamic quantities. 1 unit. Prerequisite: Chemistry 342 and 344, or equivalent.

442. **Statistical Thermodynamics.** Basic principles of classical and quantum statistics with applications to chemistry. 1 unit. Prerequisite: Chemistry 441 and 446, or consent of instructor.

445. **Physical Chemistry.** Seminar. Required of all graduate students whose major is physical chemistry. ¼ or ½ unit. Prerequisite: Consent of instructor. YANKWICH.

446. **Quantum Chemistry, I.** An introduction to quantum mechanics: basic theory and methods of approximations; applications to atomic systems. 1 unit. Prerequisite: Chemistry 349 and Mathematics 388, or equivalent; consent of instructor.

447. **Quantum Chemistry, II.** Continuation of Chemistry 446. Application of quantum mechanics to chemical problems; theories of the chemical bond; structure and spectra of molecules. 1 unit. Prerequisite: Chemistry 446 or equivalent; consent of instructor.

448. **Chemical Kinetics.** Chemical reaction and the theory of rate processes. Lectures. ¾ unit. Prerequisite: Chemistry 441 or consent of instructor.

449. **Special Topics in Physical Chemistry.** An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. Students may register for credit more than once. ½ or 1 unit. Prerequisite: Consent of instructor.

450. **Chemistry of Biological Processes.** A consideration at the molecular level of biological processes including bioenergetics, biosynthetic and degradative pathways of cellular components, metabolic regulation and enzyme reaction mechanisms. 1 unit. Prerequisite: Chemistry 350 and 355. GUNSALUS, RUTTER, WEBER.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. ¾ or 1 unit. Prerequisite: Chemistry 350 and 355. HASTINGS, TODD.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. ½ unit. Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS, STAFF.

494. **Chemical Basis of Biological Specificity.** Same as Microbiology 494. Biological formation and interaction of large molecules; analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles. Nucleic acids and their role as genetic molecules; proteins in their role as genetic products with high specific functions; metabolic interrelations of these molecules. ¾ unit. Prerequisite: Chemistry 344, 346, and 350, or 450; Microbiology 330; or consent of instructor. NISONOFF, SPIEGELMAN, WEBER.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Animal Nutrition 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. NYSTROM.

499. **Thesis Research.** A candidate for the master's degree who elects research is required to present a thesis. A thesis is always required of students working toward the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in a department other than chemistry must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. Work may be taken in the following fields, subject to the approval of one of the qualified staff members:

Analytical Chemistry. BROWNLEE, HARTLEY, JUVET, LAITINEN, MALMSTADT, PFLUGER.

Biochemistry. Carter, Clark, Conrad, Gunsalus, Hager, Hastings, Rutter, Schroepfer, C. W. Todd, Weber, Wold.

Biophysical Chemistry. Hastings, Van Holde, Weber, Wold.

Inorganic Chemistry. Bailar, Brown, Drago, Kay, Moeller, Piper, Stucky, L. J. Todd.

Organic Chemistry. Applequist, Baldwin, Beak, Curtin, Leonard, J. C. Martin, Pirkle, Rinehart, Smith, Snyder.

Physical Chemistry. Belford, Bloomfield, Drickamer, Flygare, Goodisman, Gutowsky, Hummel, Marcus, Paul, Secrest, Sim, Van Holde, Woody, Yankwich.

Chemistry:

Applied Electrochemistry—Organic and Inorganic. Swann.

Radiochemistry. Brownlee, Hummel, Kay, Nystrom.

Research for the Doctor of Philosophy is also offered in specialized fields other than those illustrated above. Students who intend to major in chemistry in one of these special fields should consult with the professor in charge of the thesis and with the head of the Department of Chemistry and Chemical Engineering in regard to the programs of courses and examinations.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and their compounds; types of bonding; survey of the periodic relationships; preparation and applications of the elements and their compounds. 3/4 unit. Prerequisite: Credit or registration in physical chemistry.

316. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. 1/2 unit. Prerequisite: Credit or registration in Chemistry 315.

321. **Chemical and Instrumental Analysis.** Chemical and instrumental methods of analysis and their application to the quantitative study of chemical reactions. 3/4 to 1 1/4 units. Prerequisite: Chemistry 336 and 340 or 342 with registration in Chemistry 343 and 344. Staff.

322. **Analytical Separations and Experimental Design.** Quantitative study of separations by chemical and instrumental analytical methods. Application of statistics to separation methods, to experimental design, and to interpretation of experimental data. 3/4 unit. Prerequisite: Chemistry 321 or equivalent. Juvet.

323. **Electronics for Chemists.** Laboratory experimentation with basic instrument components, servo systems, operational amplifiers, digital circuits, and other circuits and devices used in modern instruments for scientific research. Discussions of basic principles and specific instruments. 1/2 unit. Prerequisite: Chemistry 321 or consent of instructor. Malmstadt.

336. **Organic Chemistry.** Second course. Lectures and recitations. 3/4 unit. Prerequisite: Chemistry 133 with a grade of A or B, or Chemistry 234.

337. **Organic Chemistry.** Laboratory experiments in organic chemistry. 1/2 unit. Prerequisite: Credit or registration in Chemistry 336.

338. **Systematic Identification of Organic Compounds.** 3/4 unit. Prerequisite: Chemistry 336 and 337, or equivalent.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. 3/4 unit. Prerequisite: Chemistry 338 or consent of instructor.

340. **Principles of Physical Chemistry.** A one-semester course in physical chemistry emphasizing topics most important to students in the biological and agricultural sciences. Not open to students in the specialized curricula in chemistry or chemical engineering. 1 unit. Prerequisite: Physics 102; Chemistry 122 and 133, or equivalent; Mathematics 132 or equivalent.

341. **Elementary Physical Chemistry Laboratory.** A laboratory course to accompany Chemistry 340. ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a year-long study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. ¾ unit. Prerequisite: Chemistry 108, 122, 123, or equivalent; Physics 106, 107, and 108, or two semesters of general physics with concurrent registration in the third semester; credit or registration in Mathematics 142 or equivalent. STAFF.

343. **Physical Chemistry Laboratory.** Quantitative experimental study of chemical principles. Chemistry 343 and 345 constitute a year-long introduction to experimental physical chemistry. These courses may be taken consecutively or concurrently. ¼ unit. Prerequisite: Chemistry 342. STAFF.

344. **Physical Chemistry.** Continuation of Chemistry 342. ¾ unit. Prerequisite: Chemistry 342. STAFF.

345. **Physical Chemistry Laboratory.** Continuation of Chemistry 343. May be taken concurrently with Chemistry 343. ¼ unit. Prerequisite: Chemistry 342; credit or registration in Chemistry 343 and 344. STAFF.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins and high polymers; the use of physical methods for the characterization of such substances. ¾ or 1 unit (laboratory required for one unit). Prerequisite: Chemistry 340 or 344, and consent of instructor.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. 1 unit. Prerequisite: Chemistry 344 or equivalent.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. 1 unit. Prerequisite: Chemistry 348.

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent. CLARK, HAGER.

351. **Metabolic Processes: Problems and Methods.** Laboratory experiments stress methods of conducting metabolic experiments with tissues, cells, cell components, and enzymes. Weekly discussions consider present concepts of the mechanism of chemical transport, hormone control, energy release, and of biosynthesis. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Chemistry 350 and 355. HASTINGS.

354. **Introduction to Biochemistry.** Lectures: Structure and function of living matter, with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. 1 unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor. CONRAD.

355. **Biochemistry Laboratory.** To accompany Chemistry 350. An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituents and transformations in biological systems. Laboratory, quizzes, and assigned readings. Required of all students who expect to take advanced courses in biochemistry. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; registration in Chemistry 350. WOLD.

391. **Special Problems in Introductory Chemistry.** Designed to strengthen the chemical background of high school and junior college teachers and to integrate teaching of high school and college chemistry courses. Lectures, conferences, problems, and reports. Adaptable to individual needs. ½ or 1 unit. Prerequisite: Experience in teaching chemistry in high school or junior college.

393. **The Status of Modern Chemistry.** Lectures, demonstrations, discussions, and literature assignments in specialized areas of chemistry and chemical engineering, including analytical, inorganic, organic, and physical chemistry, biochemistry, and chemical engineering. Designed to broaden and strengthen the base of experience and knowledge of high school and junior college chemistry teachers. S; ¾ or 1 unit. Prerequisite: Experience in teaching chemistry in high school or junior college.

395. **History of Science with Particular Reference to Chemistry.** ½ unit. Prerequisite: Twenty hours of laboratory science. CAMERON.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345. It is recommended that chemistry majors take Chemistry 344 before registering in this course; concurrent registration in Physics 385 is also recommended.

397. **Radiochemistry.** Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry or atomic physics or consent of instructor. HUMMEL.

398. **Radiochemistry Laboratory.** Same as Nuclear Engineering 398. To accompany Chemistry 397. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. Laboratory and discussions. ½ unit. Prerequisite: One semester of physical chemistry or atomic physics or consent of instructor. HUMMEL.

Chemical Engineering

COURSES FOR GRADUATES

464. **Transport Phenomena.** Analysis of the various phenomena associated with transport processes; mechanism and phenomenological description; equations of change; interphase transport. Application to systems involving the transfer of energy, mass and momentum. 1 unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 373; or consent of instructor.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. ¼ unit. Prerequisite: Chemical Engineering 373.

466. **Applied Mathematics in Chemical Engineering.** The development of mathematical models and a survey of modern mathematical methods currently used in the solution of chemical engineering problems. Topics include the application of vectors and matrices, partial differential equations, numerical analysis, and methods of optimization in chemical engineering. ¾ or 1 unit. Prerequisite: Consent of instructor.

468. **Properties of Fluids.** The kinetic theory of gases and the prediction of transport coefficients; statistical mechanics applied to dense gases and liquids; theories of solutions. ¾ or 1 unit. Prerequisite: A background in modern physical chemistry and physics; consent of instructor.

469. **Special Topics in Chemical Engineering.** Various advanced topics are covered from time to time. These are generally taken during the second year of graduate study. Typical topics include turbulence, hydrodynamic instability, process dynamics, interfacial phenomena, reactor design, properties of matter at high pressure, phase transitions. ¾ or 1 unit. Prerequisite: Chemical Engineering 464.

487. **Fluid Dynamics.** Basic concepts in fluid dynamics with special emphasis on topics of interest to chemical engineers. Derivation of the Navier-Stokes equations; solutions for creeping flow, for perfect fluids, and for boundary layers; non-Newtonian fluids; turbulence. 1 unit. Prerequisite: Chemical Engineering 464.

488. **Advanced Topics in Heat and Mass Transfer.** Principles of transfer operations developed in terms of physical rate processes. Boundary layer heat and mass transfer, eddy diffusion, phase changes, and separation processes. ¾ or 1 unit. Prerequisite: Chemical Engineering 464 or consent of instructor.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. DRICKAMER, HANRATTY, HUDSON, QUINN, SANI, SCHMITZ, SWANN, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Science 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Chemistry 340 or 342 or consent of instructor; one year of calculus.

367. **Introduction to Process Control.** An introduction to the control of industrial chemical processes. Lecture and laboratory. ¾ unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 371.

368. **Chemical Engineering Kinetics.** Principles of reaction kinetics and applications to reactor design. ¾ unit. Prerequisite: Chemical Engineering 370.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342.

371. **Principles of Chemical Engineering.** Introduction to fluid dynamics and heat transfer. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor.

373. **Principles of Chemical Engineering.** Introduction to fluid dynamics and heat transfer. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 371.

374. **Unit Operations Laboratory.** To accompany Chemical Engineering 373. Laboratory and computations in the unit operation. ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373.

377. **Process Dynamics.** The basic ideas of process dynamics and their applications in chemical engineering. ¾ unit. Prerequisite: Chemical Engineering 367 or consent of instructor.

379. **Chemical Engineering Projects.** Laboratory. Development of an individual project. ½ unit. Prerequisite: Senior standing in chemistry or chemical engineering.

380. **Heat, Mass, and Momentum Transport.** A unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. ¾ unit. Prerequisite: Mathematics 343 or 345; Chemical Engineering 371; or consent of instructor.

381. **Chemical Engineering Plant Design.** Comprehensive problems, lectures, and discussion on plant design and the economic factors involved in design and operation of chemical plants. ½ unit. Prerequisite: Chemical Engineering 373.

382. **The Prediction of Physical Properties.** The prediction of equilibrium and transport properties in gases, liquids, and solids. ½ unit. Prerequisite: One year of physical chemistry.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The Department of Civil Engineering offers a combination of advanced study and participation in creative research in order to meet the needs of individual students. Such graduate training prepares students to assume greater responsibilities and to contribute to the progress of the civil engineering profession. Graduate study is offered in the following fields: air pollution; behavior, analysis and design of structures; properties of structural material; construction engineering and management; digital computer applications; foundation engineering; highways and transportation; hydrology and water resources, hydromechanics, and hydraulic structures; models research; photogrammetry and photointerpretation; radiological health; rock and soil mechanics; systems engineering; traffic engineering; urban planning and management; waste water treatment; water quality and treatment. Active research is also conducted in these areas. In addition to the facilities now available, by the end of 1965 the first phase of the new Civil Engineering Building will be ready for occupancy. The new modern facilities will be used principally for graduate study and research.

The Master of Science and Doctor of Philosophy may be attained by qualified students who satisfy the requirements of the department and the Graduate College. Progress toward an advanced degree is measured not only by the accumulation of units of credit in formal course work but also by evidence of intellectual growth and achievement. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the Bachelor of Science in the branch of the subject in which registration is desired.

The work in sanitary engineering leads to the Master of Science in Sanitary Engineering and to the Doctor of Philosophy in Sanitary Engineering. The prerequisite for admission to the first year of graduate study is a Bachelor of Science in Engineering, or in one of the physical or life sciences.

Admission to the Graduate College with full status in civil or sanitary engineering is granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois, provided the applicant's preparation is appropriate to advanced study in his chosen major field and his scholastic average is at least 4.0. Under certain conditions, applicants with a grade-point average of less than 4.0, and applicants from schools with different grading systems, may be considered if their average is at least the equivalent of 3.75 and evidence is submitted indicating that the applicant's ability is not appropriately measured by the grades submitted.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor must be approved by the head of the department.

A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units are required.

A pamphlet entitled *Graduate Study and Research in Civil and Sanitary Engineering* is available upon request to the head of the department, 205 Civil Engineering Hall.

GRADUATE FACULTY

Professors: N. M. Newmark (Head of Department), J. W. Briscoe (Associate Head of Department), W. C. Ackermann, J. E. Baerwald, V. T. Chow, E. Danner, D. U. Deere, R. S. Engelbrecht, B. B. Ewing, E. H. Gaylord, W. J. Hall, J. D. Haltiwanger, W. W. Hay, M. Herrin, H. O. Ireland, C. E. Kesler, N. Khachaturian, T. E. Larson, M. B. McPherson, W. H. Munse, W. A. Oliver, J. E. Pearson, R. B. Peck, A. R. Robinson, M. O. Schmidt, C. P. Siess, G. K. Sinnamon, M. A. Sozen, J. E. Stallmeyer, T. H. Thornburn.

Associate Professors: A. H. S. Ang, E. Chesson, Jr., A. B. Chilton, M. T. Davisson, W. H. Eldridge, S. J. Fenves, H. M. Karara, T. K. Liu, V. J. McDonald, J. L. Merritt, Jr., R. J. Mosborg, J. P. Murtha, J. T. O'Connor, R. E. Olson, A. F. Richards, W. C. Schnobrich, L. R. Shaffer, R. E. Speece.

Assistant Professors: J. H. Austin, G. C. Feng, W. L. Gamble, G. Gracie, I. Hayakawa, A. J. Hendron, E. R. Holley, Jr., W. H. C. Maxwell, R. P. Mayor, J. W. Melin, N. N. Nielsen, S. L. Paul, K. Preiss, J. K. Sridhar Rao, M. R. Thompson, C. C. Tung, W. H. Walker, H. G. Wenzel, Jr., R. N. Wright, C. Y. Yang, P. C. Yang.

COURSES FOR GRADUATES

401. Geodetic Engineering. Elements of geodesy; principles and practice of precise triangulation, traverse, and levels. 1 unit. Prerequisite: Bachelor of Science in civil engineering. Schmidt.

402. **Geodetic Engineering.** Precise astronomic determination of time, latitude, longitude, and azimuth. 1 unit. Prerequisite: Bachelor of Science in civil engineering. SCHMIDT.

403. **Photogrammetry.** Study of the principles of stereoscopy and geometrical optics; aerial cameras, their design and calibration; the design, construction, and operation of stereoscopic plotting machines; mathematics of stereoscopic orientation and model deformations. 1 unit. Prerequisite: Civil Engineering 302, or consent of instructor. KARARA.

404. **Photogrammetry.** Theory of errors of stereoscopic photogrammetry; aerotriangulation (spatial and radial), its theory and applications to various civil engineering problems; electronics in photogrammetry; practice in compiling maps from aerial and terrestrial photographs. 1 unit. Prerequisite: Civil Engineering 302, or consent of instructor. KARARA.

416. **Design of Construction and Industrial Operations, I.** Same as Industrial Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor. SHAFFER.

417. **Design of Construction and Industrial Operations, II.** Same as Industrial Engineering 417. Continuation of Civil Engineering 416. 1 unit. Prerequisite: Civil Engineering or Industrial Engineering 416; credit or registration in Mathematics 315; or consent of instructor. SHAFFER.

420. **Pavement Design, I.** Analysis and methods of measurement of surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper surface properties, load carrying capacity, wear resistance, stability, and durability. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. DANNER.

421. **Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. HERRIN.

426. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. 1 unit. Prerequisite: Civil Engineering 325 or equivalent. BAERWALD.

427. **Geometric Highway Design.** Highway classification; highway capacity; highway design controls; sight distance; horizontal and vertical alignment; cross section elements; highway types; controlled access highways; design of at-grade intersections, grade separations, and interchanges. 1 unit. Prerequisite: Civil Engineering 325 and 426, or consent of instructor. BAERWALD.

428. **Traffic Engineering Operations.** Theory of traffic control; laws and ordinances; design and application of traffic control devices; special street designations; parking design and control; street illumination; miscellaneous traffic control designs. 1 unit. Prerequisite: Civil Engineering 325 and 426, or equivalent. BAERWALD.

435. **Railway Construction and Maintenance.** Roadbed load capacity; economic design of track; advanced geometric design; economics of maintenance; grade crossing separations; review of specific projects. 1 unit. Prerequisite: Civil Engineering 335. HAY.

436. **Railroad Location and Operation.** Track and traffic capacity; optimum train size, performance, and scheduling; validity and accuracy of current practices; regional operating factors; optimum size of plant and modern location. 1 unit. Prerequisite: Civil Engineering 336 or consent of instructor. HAY.

440. **Theory of Water Treatment.** Properties of water and criteria of water quality; gas transfer operations in water treatment; chemical treatment processes; corrosion and corrosion control; sedimentation; filtration; disinfection; control of aquatic growths; control of tastes and odors. 1 unit. Prerequisite: Chemistry 122 and Microbiology 101. EWING, O'CONNOR.

441. **Water Purification Laboratory and Design.** An extension of principles and application to experimental determination of design and operational criteria for various physical, chemical, and biological unit operations used in water purification processes. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440 or consent of instructor. AUSTIN, O'CONNOR.

442. **Theory of Waste-Water Treatment.** Composition, properties, and analysis of wastes; microbiology of waste treatment; pollution of natural waters; sedimentation; chemical treatment; aerobic and anaerobic treatment processes; disposal of waste sludges. 1 unit. Prerequisite: Chemistry 122 and Microbiology 101. ENGELBRECHT, SPEECE.

443. **Waste Treatment Laboratory and Design.** An extension and application to experimental determination of design and operational criteria for various physical, chemical, and biological unit operations used in waste treatment processes. 1 unit. Prerequisite: Credit or registration in Civil Engineering 442. AUSTIN, SPEECE.

444. **Industrial Wastes.** Advanced considerations of industrial wastes problems of major waste-producing industries including the process producing the waste, waste composition, treatment methods, and inplant abatement techniques. ½ or 1 unit. Prerequisite: Civil Engineering 442 and 443, or consent of instructor. ENGELBRECHT, O'CONNOR.

445. **Fundamentals of Biological Treatment.** A detailed consideration of basic biological and chemical phenomena applied to aerobic and anaerobic treatment of aqueous wastes. 1 unit. Prerequisite: Credit or registration in Civil Engineering 443, or consent of instructor. ENGELBRECHT, SPEECE.

446. **Design of Water and Waste Treatment Plants.** A study of the fundamental factors affecting choice of treatment units and combination of unit processes into an integrated plant. 1 unit. Prerequisite: Civil Engineering 440, credit or registration in Civil Engineering 442, or consent of instructor. EWING, O'CONNOR.

447. **Radioactive Waste Disposal.** Same as Nuclear Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous wastes disposal; air monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282 or Chemistry 398 (Nuclear Engineering 398), or consent of instructor. AUSTIN, EWING.

450. **Advanced Hydrologic Analysis and Design.** Hydrologic cycle; hydrometeorology; collection of data; hyetograph and hydrograph analyses; infiltration and evapotranspiration studies; groundwater exploration and recharge; statistical analyses; determination of waterway areas; flood routings; river and reservoir regulations; design and planning of flood control projects; and modern development such as radar weather, radioactive tracers, disposal of nuclear wastes, and electronic analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW.

452. **Water Resources.** An advanced interdisciplinary course on water resources planning and development; geographic aspects; data collection; governmental functions; hydrologic implications; river hydraulics; hydraulic physical units and water quality; economic aspects; legal, political, and social problems; case studies. 1 unit. Prerequisite: Consent of instructor. CHOW, STAFF.

456. **Hydraulics of Surface Drainage.** Applications of hydraulics and hydrologic principles; elements of channel design, hydrologic determination of design flow, hydraulics of culverts and bridge openings, overland flow, flow in gutters and inlets, and hydrologic and hydraulic design of a bridge opening or culvert system. 1 unit. Prerequisite: Theoretical and Applied Mechanics 235. MCPHERSON.

457. **Ground Water.** An advanced interdisciplinary course on ground water; hydrogeology; hydrodynamics of flow through porous media; ground water hydrology; hydraulics of wells; hydraulic analysis of seepage; ground water pollution; ground water resources. 1 unit. Prerequisite: Consent of instructor. CHOW, STAFF.

458. **Open-Channel Hydraulics.** Basic hydromechanics; flow types; channel characteristics; flow-profile computations; hydraulic jump analysis; design of nonerodible, erodible, and grassed channels and transitional structures; study of supercritical flow and unsteady flow; modern developments in theory and design practice; application of numerical method, method of characteristics, method of singular point, and electronic digital computers and analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW, MURTHA.

460. **Structural Analysis.** Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quantitative influence lines. 1 unit. Prerequisite: Bachelor of Science in engineering with a course in theory of simple structures. GAYLORD, OLIVER.

461. **Structural Theory and Design.** Advanced structural theory from the standpoint of design, analysis, and behavior, with particular emphasis on analysis; evaluation of methods of elastic analysis of structures; limit design and analysis; continuous beams and frames; multiple-story structures; space frames; arches. 1 unit. Prerequisite: Bachelor of Science in civil engineering; Civil Engineering 361 or 460, or equivalent. FENVES, HALL, STALLMEYER.

462. **Structural Theory and Design.** Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long span roofs. 1 unit. Prerequisite: Bachelor of Science in civil engineering; Civil Engineering 361 or 460, or equivalent. MOSBORG, STALLMEYER.

464. **Reinforced Concrete Design.** Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. 1 unit. Prerequisite: Bachelor of Science in engineering with courses in structures. BRISCOE.

465. **Structural Design in Metals.** Theories of behavior of structural metal members and their components; interpretation of codes and specifications for the design of bridges and buildings. This course and Civil Engineering 475 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Bachelor of Science in engineering with courses in structures. GAYLORD.

467. **Behavior of Reinforced Concrete Structures.** Ultimate strength and behavior of statically indeterminate reinforced concrete structures; applicability of elastic analysis to framed structures; analysis and design of floor slabs in buildings. 1 unit. Prerequisite: Civil Engineering 366. SIESS.

468. **Analysis and Design of Prestressed Concrete Structures.** Principles of linear prestressing; the properties of materials used in prestressed concrete; service load and ultimate design of simply supported prestressed concrete beams; strength and behavior of prestressed concrete beams; composite sections; analysis, behavior, and design of continuous prestressed concrete beams. 1 unit. Prerequisite: Bachelor of Science in civil or architectural engineering with courses in reinforced concrete and in analysis of indeterminate structures. KHACHATURIAN.

470. **Statistical Theory of Structural Engineering.** Study of the concepts and applications of probability and statistical theory in structural engineering and research, with emphasis on the scientific principles for considering fluctuations and randomness in physical phenomena and processes; mathematical modeling in structural mechanics including Monte Carlo simulation in structural systems analysis and design; engineering decision-making under uncertainty; analysis of loads and resistances; safety analysis of structures including system reliability prediction; introduction to stochastic structural dynamics. 1 unit. Prerequisite: Consent of instructor. ANG.

471. **Numerical and Approximate Methods of Structural Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments and deflections of plates, other problems. 1 to 2 units. MELIN, ROBINSON.

472. **Advanced Numerical Methods in Engineering.** Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures; blast, impact, and earthquake effects on structures; buckling and flexure of frameworks; torsion of solid and thinwalled sections; lateral buckling of beams; bending and buckling of plates and of stiffened plates; plane stress and axially symmetric problems in elasticity; other topics. 1 to 2 units. Prerequisite: Civil Engineering 471. ROBINSON, C. Y. YANG.

473. **Analysis and Design of Plates and Shells.** Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highways and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs, and hipped plate construction. 1 and 2 units. Prerequisite: Consent of instructor. SCHNOBRICH.

474. **Behavior of Structures Under Dynamic Loads.** Free vibrations, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analytical methods for the effects of wind load, explosion blast, impact, earth tremors, and other time-dependent excitations; effects of damping and inelastic action; propagation of stress waves; wind-induced vibrations with application to cables, pipelines, and tall stacks. 1 to 2 units. Prerequisite: Consent of instructor. WALKER.

475. **Behavior of Steel Structures.** A critical evaluation of the actual behavior of metals, connections, members, and structures; the significance of this behavior in terms of design and the development of design specifications. This course and Civil Engineering 465 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Graduate standing in civil engineering or theoretical and applied mechanics. CHESSON, MUNSE.

476. **Plastic Analysis and Design.** Inelastic behavior of metal structural frameworks; concept of the plastic hinge; collapse configurations; analysis of

collapse mechanisms; requirements for stability; deflections, incremental collapse, shakedown; connections; optimum design; grid frameworks. 1 unit. Prerequisite: Civil Engineering 465 or consent of instructor. GAYLORD.

477. **Design of Structures for Dynamic Loads.** Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast-resistant structures; criteria for design of earthquake-resistant structures; application to actual problems. 1 unit. Prerequisite: Consent of instructor. HALTIWANGER, NEWMARK.

478. **Matrix Theory of Structural Mechanics.** Fundamental concepts of matrix calculus and its applications for a unified treatment of advanced structural mechanics and dynamics; basic calculus of matrices; iterative solution of systems of algebraic and differential equations; stress and structural analysis, method of tearing tensors; discrete simulation of continuous systems in higher dimensions; eigen-value problems of discrete systems. 1 unit. Prerequisite: Civil Engineering 461 or 471, or consent of instructor. ANG.

479. **Applied Structural Mechanics.** Study of beams under lateral load; beams with combined lateral load and thrust; buckling; beams on elastic foundations; applications of Fourier series and virtual work principles to beam-type structures; stress and strain in three dimensions; applications to flexure of beams and plates and to constrained torsion; elements of the engineering theory of plates. 1 unit. Prerequisite: Mathematics 345 and one undergraduate course in statically indeterminate structures, or consent of instructor. ROBINSON.

480. **Earth Pressures and Retaining Structures.** Classical and modern earth pressure theories and their experimental justification; pressures and bases for design of retaining walls, bracing of open cuts, anchored bulkheads, cofferdams, tunnels, and culverts. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384. IRELAND.

481. **Earth Dams and Related Problems.** Fundamentals of problems of slope stability; seepage in composite sections and anisotropic materials; methods of stability analysis; mechanism of failure of natural and artificial slopes; compaction; field observations. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384, or consent of instructor. IRELAND, PECK.

482. **Measurement of Soil Properties.** Laboratory and field work in soil sampling, classification, and testing; experimental studies of modern soil mechanics parameters and theories with emphasis on applications to design problems. Experiments include permeability, consolidation, direct shear, and triaxial shear. The research approach is used to point out interpretations and limitations of data in practice. 1 unit. Prerequisite: Credit or registration in Civil Engineering 383, or consent of instructor. OLSON.

483. **Soil Mechanics.** Advanced studies of research techniques in soil mechanics and foundation engineering. 1 unit. Prerequisite: Civil Engineering 384 or consent of instructor. OLSON.

484. **Foundation Engineering.** Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. 1 unit. Prerequisite: Civil Engineering 384. IRELAND, PECK.

485. **Soil Engineering for Transportation Facilities.** Problems of soil classification; evaluation of stability of natural and compacted soils as subgrades, slopes, and embankments; effect of climate, soil properties, compaction, and admixtures on subgrade stability. 1 unit. Prerequisite: Civil Engineering 383 or equivalent. LIU, THORNBURN.

492. **Measurement Theory and Experimental Design.** The principles of engineering experimentation from both a classical and a statistical point of view. Nature of experimental error; test planning; data analysis; special techniques. Examples within the civil engineering discipline are emphasized. 1 unit. Prerequisite: Mathematics 263 or equivalent. CHILTON.

494. **Municipal Administration and Engineering.** Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning; building codes and inspection; street lighting; public utilities; city cleaning; recreational development. 1 unit. Prerequisite. Bachelor of Science in civil engineering or consent of instructor. DANNER.

495. **Civil and Sanitary Engineering Seminar.** Discussion of current topics in civil and sanitary engineering and related fields by staff, students, and visiting lecturers. Course may be repeated. 0 or ¼ unit.

497. **Special Problems.** Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the investigation. 0 to 4 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Surveying.** Precise horizontal and vertical control surveys; state plane coordinate systems; special construction surveys. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

302. **Photogrammetric Engineering.** A study of metrical photography in civil engineering practice; characteristics and interpretation of aerial and terrestrial photographs; stereoscopic compilation of maps from photographs; mosaics; economics of photogrammetry; map reproduction. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

303. **Property Location Surveys.** Original, retracement, and subdivisional surveys in relation to real property. ½ or 1 unit. Prerequisite: Civil Engineering 201 or consent of instructor.

305. **Observational Astronomy.** Same as Astronomy 314. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143.

314. **Fundamentals of Systems Approach.** Introduction to the application of linear programming, network theory, and queueing theory to the synthesis of civil engineering systems. ½ or 1 unit. Prerequisite: Civil Engineering 215, Mathematics 263 or consent of instructor.

315. **Construction Productivity.** Introduction to the application of scientific principles to the measurement of and the forecasting of productivity in construction engineering; conceptual and mathematical formulations of the labor, equipment, and material factors affecting productivity. ½ or 1 unit. Prerequisite: Civil Engineering 215; credit or registration in Mathematics 263 or equivalent; or consent of instructor.

316. **Construction Planning.** Introduction to the application of scientific principles to the normative planning of construction operations. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

318. **Construction Cost Analyses and Estimates.** Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts of and statistical measurements of the factors involved in

direct costs, general overhead costs, cost mark-ups and profits; the fundamentals of cost recording for construction cost accounts and cost controls. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

321. **Bituminous Materials and Mix Design.** Properties and control testing of bituminous materials; analysis of bituminous paving mixtures; composition and design of asphaltic concrete and soil-asphalt mixes. ½ unit. Prerequisite: Civil Engineering 214 and 220, or consent of instructor.

322. **Development of Highway Facilities.** Analysis of factors in developing a highway transportation facility; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; highway maintenance planning. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

325. **Highway Traffic Characteristics.** Vehicle operating characteristics; driver characteristics; pedestrian characteristics; roadway characteristics as they individually, and collectively as traffic stream characteristics, are related to the planning, design, and operation of highway facilities. ½ unit. Prerequisite: Civil Engineering 220 or consent of instructor.

333. **Urban and Regional Transportation.** Importance of transportation and its relation to urban and regional planning; characteristics of transport systems; transportation planning including surveys, data analysis, and problems of administration and finance; coordination and integration of transport. ½ or 1 unit. Prerequisite: Consent of instructor.

334. **Airport Design.** Basic principles of site selection for airports and fundamental considerations of design, construction, and maintenance of airport pavements and structures. ½ or 1 unit. Prerequisite: Civil Engineering 220 and senior standing in civil engineering, or consent of instructor.

335. **Railway Construction and Maintenance.** Loads and load distribution on track and subgrade; roadbed construction and stabilization; track stresses, design, and materials; turnouts and crossings; maintenance programs. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

336. **Railway Location and Operation.** Influence of traffic, alignment, distance, gradients, and active power upon operating expenses; mechanics of train operation; economic design of location. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

337. **Signals.** Train movements; systems of signals; track circuits; track capacity; interlockings; economics of signaling. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

338. **Terminals.** Design and operation of freight terminal facilities for rail, highway, air, and water carriers; passenger terminals; special terminal requirements for specific commodity categories; coordination. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

345. **Public Health Engineering.** The application of engineering principles to the control of environmental sanitation, including administration, biostatics, communicable disease control, epidemiology, industrial health and air contamination, housing, vector control, radiological health, refuse collection and disposal, milk and food sanitation, swimming pools, and individual water supply and waste water disposal. ½ unit. Prerequisite: Consent of instructor.

348. **Air Pollution.** A study of the characteristics of air contaminants from industrial and domestic sources; their effect and methods of control; air pollution surveys; organization of control programs. ½ unit. Prerequisite: General Engineering 360 or consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Nuclear Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry; sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Nuclear Engineering 397 or Physics 382, or equivalent.

351. **Hydromechanics.** Applied fiuid mechanics with particular reference to topics in hydraulic design, analysis, and research in civil engineering areas; covers dimensional analysis and dynamic similarity, analysis of potential flow, boundary-layer problems, turbulence and diffusion. Hydraulic transients, water waves, transport phenomena. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 251.

352. **Water Resources Design.** Study and evaluation of phases of river mechanics; water resources history and project implementation; development of a water resources project plan. ¾ unit. Prerequisite: Civil Engineering 250; Theoretical and Applied Mechanics 235.

353. **Hydraulic Structures.** Introduction to the design of hydraulic structures, including consideration of types and function of dams; hydrologic design; hydraulic design of spillways and outlet works; determination of loads and stresses for concrete structures; seepage, piping, and stability of earth structures. ¾ unit. Prerequisite: Civil Engineering 250 and 251.

354. **Hydraulic Engineering Laboratory.** Fundamental principles, operation, and use of model laboratories; dimensional analysis; hydraulic similitude; theory and design of hydraulic models as applied to a specific laboratory problem. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235.

361. **Advanced Structural Analysis.** Numerical methods of structural analysis; general theory of continuity; prismatic and nonprismatic members; continuous framed structures; trussed structures; lateral load distribution; secondary stresses. ¾ or 1 unit. Prerequisite: Civil Engineering 262 or equivalent.

363. **Behavior and Design of Metal Structures, II.** Members under combined loads; welded, riveted, and bolted connections; moment-resistance connections; plastic design. ¾ or 1 unit. Prerequisite: Civil Engineering 263 or consent of instructor.

364. **Reinforced Concrete Design, II.** Limit design of continuous reinforced concrete members and slabs of various types. ¾ or 1 unit. Prerequisite: Civil Engineering 264; credit or registration in Civil Engineering 262.

366. **Behavior of Reinforced Concrete Members.** Ultimate strength and behavior of reinforced concrete members and relation between results of research and current specifications for design; members subjected to flexure, axial compression, combined flexure and axial load, combined flexure and shear, and bond. 1 unit. Prerequisite: Bachelor of Science in civil engineering or architecture with courses in structures and reinforced concrete design.

368. **Prestressed Concrete.** Principles and methods of linear prestressing; behavior, strength, and design of noncomposite simple beams, composite simple beams, and continuous beams; time-dependent variables and long-time deflections. ¾ or 1 unit. Prerequisite: Civil Engineering 262 and 264.

369. **Behavior and Design of Wood Structures.** Theory and practice in design of modern wood structures; effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the

development of design formulae, ¾ or 1 unit. Prerequisite: Civil Engineering 261 or equivalent, or consent of instructor.

380. **Foundation Engineering.** Evaluation of subsoil conditions as they affect the behavior, proportions, and choice of type of foundations; bearing capacity and settlement analyses; character of natural soil deposits; earth pressure theories and retaining wall analysis; slope stability. 1 unit. Prerequisite: Civil Engineering 210.

383. **Soil Mechanics.** Identification, description, and classification of soils; index properties, weight-volume relationships; hydraulic properties; stress-deformation characteristics; ultimate strength; subsurface exploration; character of natural soil deposits. ¾ or 1 unit. Prerequisite: Consent of instructor.

384. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; earth pressure and retaining walls; braced cuts; damage due to construction operations. ¾ or 1 unit. Prerequisite: Civil Engineering 383 or consent of instructor.

385. **Engineering Aspects of Surficial Soils.** Use of geologic and pedologic information and airphoto interpretation techniques in the prediction of engineering properties of soils and the planning of engineering soil surveys. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Civil Engineering 210 or consent of instructor.

391. **Numerical and Computer Applications in Civil Engineering.** Introduction to digital computers and their programming; development of methods for the efficient use of computers in the solution of design and other problems; description of applications; discussion of role of computers in performing engineering computations. ½ or 1 unit. Additional work required for more than ½ unit of graduate credit. Prerequisite: Graduate standing in civil or achitectural engineering, or consent of instructor.

THE CLASSICS

The Department of Classics offers graduate work leading to the Master of Arts and Doctor of Philosophy.

The Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. In all cases, the requirement of a master's thesis is waived; extra units of work in Greek or Latin are substituted for the thesis.

The Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All graduate students should take Greek or Latin 495-496, Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a departmental brochure which may be obtained by applying to the head of the department, 360 Lincoln Hall.

GRADUATE FACULTY

Professors: J. L. Heller (Head of Department), R. P. Oliver, A. Tovar, A. Turyn.

Associate Professor: J. J. Bateman.

Assistant Professors: W. P. Donovan, M. Naoumides.

Classical Civilization

The following courses presuppose no knowledge of the Greek or Latin language and are open to all students. For other courses in the area of classical civilization, see Art 311; History 381, 382, 383, and 384; and Philosophy 303 and 309.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Classical Literary Traditions, I.** Greek literature from Homer to Aristotle. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. BATEMAN.

302. **Classical Literary Traditions, II.** Literary forms in the Alexandrian and Roman periods. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. BATEMAN.

318. **Elements of Technical Terminology.** Presentation and analysis of Greek and Latin prefixes, suffixes, and root-words basic in the vocabularies of modern science, especially botany, psychology, zoology, and medicine. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent, or completion of twenty hours of science or architecture. HELLER.

361. **The Archaeology of Greece.** Monuments and material remains illustrating the development of Greek civilization to 323 B.C. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. DONOVAN.

362. **The Archaeology of Italy.** Monuments and material remains illustrating the development of Graeco-Roman and other ancient Italian civilizations to 330 A.D. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. DONOVAN.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 360 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. **Greek Versification.** Greek prosody: survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. 1 unit. TURYN.

411. **Hellenistic Literature.** 1 unit.

412. **Lucian and His Age.** 1 unit.

413. **Greek Lyric Poetry.** 1 unit. TURYN.

414. **Pindar.** 1 unit. TURYN.

415. **Homer.** 1 unit.

416. **Thucydides.** 1 unit.

417. **Bacchylides.** 1 unit. TURYN.

422. **Sophocles.** 1 unit. TURYN.

423. **Aeschylus.** 1 unit. TURYN.

424. **Euripides.** 1 unit. TURYN.

425. **Greek Drama: Comedy.** 1 unit. TURYN.

491. **Directed Reading.** ½ unit. Prerequisite: Second-year graduate standing.

495. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Latin 496. ½ unit. OLIVER.

499. **Thesis Research.** Same as Latin 499. Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, OLIVER, TOVAR, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Comparative Grammar of Greek and Latin.** Same as Latin 308. A historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. TOVAR.

391. **Readings in Greek Literature.** Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. ¾ unit. Prerequisite: Two years of college Greek; consent of instructor. STAFF.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. Two of the four required units in Latin must be in courses numbered above 400; the other two units are Latin 311, 312, and 391. The required work in education consists of Educational Psychology 311 and 312 and one unit selected from History and Philosophy of Education 301, 302, 303, 304. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. L. Heller, 358 Lincoln Hall.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 360 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is four years of college Latin or equivalent.

401. **Readings in Latin for Graduate Students.** Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. No graduate credit. Prerequisite: Two years of high school Latin or equivalent. BATEMAN.

409. **History of the Latin Language.** 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language. TOVAR.

410. **Vulgar Latin.** 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language. TOVAR.

411. **Latin Epigraphy.** 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.

412. **Latin Elegy.** 1 unit. OLIVER.
413. **Caesar.** 1 unit. TURYN.
414. **Lucan.** 1 unit. OLIVER.
415. **Lucretius.** 1 unit. TOVAR.
416. **Vergil.** 1 unit. TURYN.
421. **Horace.** 1 unit. TURYN.
422. **Plautus and Terence.** 1 unit. TURYN.
423. **Latin Romance.** 1 unit. TOVAR.
425. **Cicero.** 1 unit. TURYN.
426. **Tacitus.** The *Annales.* 1 unit. OLIVER.
427. **Roman Satire.** 1 unit.
441. **Latin Paleography.** 1 unit. OLIVER.
491. **Directed Reading.** ½ unit. Prerequisite: Second-year graduate standing.
495. **Bibliography and Criticism.** Same as Greek 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.
496. **Bibliography and Criticism.** Same as Greek 496. ½ unit. OLIVER.
499. **Thesis Research.** Same as Greek 499. Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, OLIVER, TOVAR, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Comparative Grammar of Greek and Latin.** Same as Greek 308. A historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. TOVAR.
311. **Advanced Latin Composition.** Practice in the writing of Latin prose. ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. OLIVER.
312. **Advanced Latin Composition.** ½ unit. Prerequisite: Latin 311. OLIVER.
313. **Oral Latin.** Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.
391. **Readings in Latin Literature.** Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations,* Seneca, Ovid, Cicero's *Essays,* Patristic Latin, Medieval Latin. ¾ unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

Doctor of Philosophy in Communications. This program is administered by the Committee on Graduate Study in Communications, an interdepartmental committee of the Graduate College faculty. It provides a core program in communications and permits advanced specialization in several areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics.

The program applies the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communications. It is intended for students who plan careers in teaching communication subjects such as journalism, radio-television, and psycholinguistics; scholarly research on the development, control, and ethics of the mass media; experimental research on public opinion measurement; advertising,

communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission is a 4.0 grade average and a broad background in the social sciences and humanities. Many of the advanced courses have introductory courses as prerequisites. An introductory course in statistics is generally useful.

A candidate for the Doctor of Philosophy in Communications must complete at least twenty-four units of graduate work. The program provides both an introduction to the broad field of communications with its related disciplines (requirements 1, 2, and 4, below), and specialization in a subfield (requirements 3 and 5). The student must meet these detailed requirements:

(1) Communications 471 and 472, Proseminar, two units.

(2) One unit selected from Group A (Communications 414, 432, 444, 462, 468, 470, 473, 474, 481, 483, 307, 308, 344, 360, 372), and one unit from Group B (Communications 420, 424, 425, 426, 451, 456, 325, 370).

(3) An area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics (illustrated by Group B above). Occasionally the Committee will approve other specializations. Two units must be taken in courses in research methods; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research. Courses for the area of specialization are not limited to courses cross-listed with communications. With his adviser's approval, a student may offer any relevant graduate course as part of the major.

(4) Either a sole minor of four units in a discipline other than communications, or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa*.) Courses cross-listed in communications may not be counted toward a minor in a discipline other than communications.

(5) Communications 499, Thesis Research, eight units.

(6) Language requirements of the Graduate College.

(7) A preliminary written and oral examination.

(8) A final oral examination centered on but not restricted to the field of the dissertation.

The student selects an adviser as soon as possible after entering the program. He may change advisers, however, if his area of anticipated specialization shifts.

Minor. A candidate for the Doctor of Philosophy wishing to minor in communications should select four, three, or two units (according to the requirements of his major department). Communications 471 and 472 are recommended as giving a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background for the courses they choose.

Requests for further information about the program should be addressed to the chairman of the administrative committee, Professor Theodore Peterson, 119d Gregory Hall.

THE INSTITUTE OF COMMUNICATIONS RESEARCH

The Institute is an interdisciplinary group studying problems relating to the communications process and its role in society. Its staff consists of research professors, usually with joint appointments in the Institute and in related departments, and graduate student research assistants. The backgrounds of the staff range from linguistics, through psychology and the other social sciences, to journalism and other disciplines concerned with the mass media. Graduate students in the communications program often take part in the research activities of the Institute

and have access to the personnel and facilities of this unit of the College of Journalism and Communications. Inquiries about the Institute should be addressed to its director, Professor Charles E. Osgood, 120 Gregory Hall.

GRADUATE FACULTY

Professors: T. Peterson (Chairman of Committee on Graduate Study in Communications), J. B. Casagrande, C. B. Hagan, J. E. Hulett, H. L. Mueller, C. E. Osgood, C. H. Sandage, H. J. Skornia, I. D. Steiner, R. E. Stevens.

Associate Professors: J. W. Jensen, L. Linsky, H. S. Maclay, C. J. McIntyre, J. E. Moyer, Rita J. Simon.

Assistant Professors: R. L. Brown, J. W. Carey, M. E. Fishbein, L. A. Jakobovits, M. S. Miron, J. L. Simon, Nancy Wiggins.

COURSES FOR GRADUATES

414. **Seminar on Social Interaction.** Same as Sociology 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

420. **Seminar in Semantics.** Same as Philosophy 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. Linsky.

424. **Linguistics and Communication.** Same as Linguistics 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. Maclay.

425. **Psycholinguistics.** Same as Linguistics and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory, and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. Osgood.

426. **Research Seminar in Psycholinguistics.** Same as Linguistics and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Communications 425; consent of instructor. Maclay, Osgood.

432. **History of Books and Printing.** Same as Library Science 432. The origin and evolution of the alphabet and of scripts; the history of manuscript books; the invention and spread of printing; the account of the production and distribution of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. 1 unit. Stevens.

435. **Fundamentals of Cybernetics.** Same as Biophysics 435 and Electrical Engineering 473. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 394 or Mathematics 361, or consent of instructor. Ashby.

436. **Problems of Cybernetics.** Same as Biophysics 436 and Electrical Engineering 474. A continuation of Electrical Engineering 473. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Communications 435. Ashby.

444. **Seminar in Public Opinion.** Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. R. SIMON.

451. **Advanced Social Psychology.** Same as Psychology 451. A systematic and critical treatment of individual behavior variables in relation to group variables. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 255 or equivalent. STEINER.

456. **Psychology of Social Communication.** Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor. FISHBEIN.

462. **Seminar in Radio and Television.** Same as Radio-Television 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. SKORNIA.

468. **The Political Economy of Communications.** Same as Journalism 468. Analysis of theory and problems concerning such social agencies of communication as telephone, radio services (including television), and motion pictures, with special emphasis on their policies and structures. 1 unit.

470. **Communications and Popular Culture.** Same as Journalism 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit. BROWN.

471. **Proseminar in Communications, I.** Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. 1 unit. CAREY, STAFF.

472. **Proseminar in Communications, II.** Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. MACLAY, STAFF.

473. **History and Theory of Freedom of the Press.** Same as Journalism 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. CAREY, JENSEN.

474. **Communications Systems.** Same as Journalism 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. CAREY.

481. **Advanced Advertising Principles.** Same as Advertising 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Communications 481 and Advertising 388. 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Advertising 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitive and quantitative methods are examined. 1 unit. J. SIMON.

483. **Advertising and the Mass Media.** Same as Advertising 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit. MOYER.

490. **Special Topics in Communications.** ½ to 2 units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications. STAFF.

492. **Research Methods in Communications.** Same as Journalism 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. WIGGINS.

499. **Thesis Research.** 0 to 4 units. Students may re-register for a total of eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **The Art of the Screen: Narration.** Same as Speech 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. **The Art of the Screen: Exposition and Persuasion.** Same as Speech 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

325. **Introduction to Psycholinguistics.** Same as Linguistics 325. An introductory survey of psychological and linguistic approaches to the study of communication. ½ or 1 unit. Prerequisite: An introductory course in linguistics or psychology. MACLAY, MIRON.

344. **Public Opinion.** Same as Sociology 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. R. SIMON.

360. **Educational Uses of Television and Radio.** Same as Secondary and Continuing Education and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

370. **Language, Culture, and Society.** Same as Anthropology and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

372. **Social Aspects of Mass Communications.** Same as Journalism and Sociology 372. Media structures related to cultural content and functions. Problems of life and society as treated in mass-produced communications. ½ unit.

COMPARATIVE LITERATURE

The program leading to the Master of Arts and Doctor of Philosophy degrees in Comparative Literature is designed to make possible a systematic study of subjects and problems common to several literatures. Its purpose is to enable stu-

dents who have greater than average linguistic competence and preparation to explore (1) the interrelations of several modern literatures; (2) the main currents, periods, and movements in modern European literary history; and (3) the theory of literature and criticism. The program is supervised by a committee made up of the heads and chairmen of the classical and modern language departments. (For purposes of this description, English is included among the modern language departments.) The student's program of study is supervised by an adviser in the department of his major interest. A student entering the program must have majored in one of the modern languages as an undergraduate, must have attained an undergraduate grade average of 4.0, and must present evidence of having acquired a reading knowledge of two modern foreign languages. Some knowledge of Latin and Greek is also recommended, and is necessary for students planning to specialize in the Medieval or Renaissance periods.

Master of Arts. A candidate for the Master of Arts in Comparative Literature must offer four units of credit in one modern language, Comparative Literature 401, and two units of credit in a second modern language. The courses chosen from the second modern language department must be approved by the adviser; and at least four of the courses, in addition to Comparative Literature 401, must be chosen at the 400 level. The candidate must also pass an examination based on a reading list and designed to test his knowledge of the literature of his main interest as well as his ability to interpret a literary or critical text. A master's thesis is not required, although the student may elect to offer one with the approval of his adviser.

Doctor of Philosophy. A candidate for the Doctor of Philosophy in Comparative Literature must fulfill the general requirements of the Graduate College. He must take at least four units of work in Comparative Literature 451 and 461. Four additional units of work at the 400 level are to be taken in courses regularly offered by the modern language departments. The candidate will be responsible for a knowledge of the history of the literature in one modern language. He must also select a period of major interest, and will be responsible for a knowledge of two other literatures in this period, which will be considered as minors. The periods may be either (1) Medieval, (2) Renaissance, (3) Neo-Classicism and the Enlightenment, or (4) Romanticism and the Modern Period. He must pass a preliminary examination (a three-part written examination, plus an oral examination), and present a thesis in which he has investigated a topic with ramifications of a comparative nature.

Inquiries concerning the program in comparative literature should be addressed to the Graduate Program in Comparative Literature, 244 Lincoln Hall.

COURSES FOR GRADUATES

401. **Theory of Literature.** The methods and objectives of the discipline of comparative literature. 1 unit. Prerequisite: Reading knowledge of two modern foreign languages; consent of instructor.

451. **Seminar in Literary Movements.** An investigation of the development and mutation of literary movements (classicism, romanticism, symbolism, etc.) through a study of critical texts and their reception in various countries. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit. Prerequisite: Comparative Literature 401.

461. **Seminar in Literary Forms and Types.** A study of a form (the lyric, the novel, etc.) or a type (the romantic hero, the Faust myth, tragedy, satire, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

499. **Thesis Research.** Intended for students engaged in writing a thesis as a partial requirement for the A.M. or Ph.D. degree in Comparative Literature. 0 to 4 units.

COMPUTER SCIENCE

The Department of Computer Science offers instruction in courses and the supervision of theses for individuals specializing in the design and use of digital computing machinery. The laboratory operates an IBM 7094-1401 computing system for general University use in research and instruction. Presently active areas of research include numerical analysis, Monte Carlo methods, programming, algebras of switching circuits, direct coupled computer circuits using transistors, high-speed memories, pattern recognition, and logical design of computers. In addition, the department has constructed a very high-speed computer of its own design (Illiac II). At present this computer is being augmented with a flexible complement of input-output equipment including the possibility of remote consoles. The department is also engaged in the design and construction of a general purpose pattern recognition computer (Illiac III). This expansion of facilities is intended in part to meet the expanding needs of the University and of the department in the area of data processing and scientific computation.

Members of the staff who are engaged in computer research regularly offer sixteen courses: Mathematics 195, 295, 387, 395, 397, 457, 458, 488, 489; Mathematics or Electrical Engineering 294, 391, 392, 393, 394, 497, 498. There is also a weekly colloquium (no credit).

Although no advanced degree is offered by the Department of Computer Science, candidates for advanced degrees in electrical engineering, mathematics, or physics who are interested in this area of study may engage in thesis work under the supervision of one of the staff members of the department. Requests for additional information concerning the work of the department and applications for assistantships should be directed to the head of the Department of Computer Science.

GRADUATE FACULTY

Professors: J. R. Pasta (Head of Department), J. N. Snyder (Associate Head of Department), L. D. Fosdick, D. B. Gillies, B. H. McCormick, S. Muroga, W. J. Poppelbaum, J. E. Robertson.

Associate Professors: N. T. Hamilton, K. C. Smith.

Assistant Professors: J. R. Ehrman, H. G. Friedman, C. W. Gear, S. R. Ray.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology and microbiology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.75.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. Candidates for the Master of Science must complete one-half unit of Dairy Science 490 and two units of Dairy Science 499. For the Doctor of

Philosophy, one and eight units, respectively, of these courses are required. Others course requirements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the Master of Science are expected to complete an acceptable thesis unless the Dean of the Graduate College waives this requirement. All students expecting to continue graduate studies should fulfill the thesis requirements for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science also is required.

For a minor in dairy science, students should select an adviser in this area of study to determine the specific courses required. For the Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science, of which two units must be in 400-level courses; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

GRADUATE FACULTY

Professors: G. W. Salisbury (Head of Department), H. P. Broquist, K. E. Harshbarger, K. A. Kendall, R. W. Touchberry.

Associate Professors: R. E. Brown, M. P. Bryant, J. H. Byers, R. L. Hays, B. L. Larson, J. R. Lodge, M. J. Wolin.

Assistant Professors: C. L. Davis, J. C. DeFries, C. N. Graves.

COURSES FOR GRADUATES

402. The Microbiology and Physiology of Ruminant Nutrition. The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. ¾ unit. Prerequisite: Chemistry 350, 355, or equivalent. Brown.

408. Physiology of Lactation. The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. ½ to 2 units. Hays.

411. Population Genetics and Animal Breeding. Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. Touchberry.

412. Advanced Endocrinology. Same as Animal Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. This course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. Gorski, Nalbandov.

430. Physiology of Mammalian Germ Cells. A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. Lodge, Salisbury.

440. Design and Analysis of Biological Experiments, I. Same as Agronomy, Animal Science, Horticulture, and Veterinary Medical Science 440. A study

of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. CARMER.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Horticulture, and Veterinary Medical Science 441. A continuation of Dairy Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Dairy Science 440 or equivalent. CARMER.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. ½ to 2 units. Prerequisite: Ten hours of advanced microbiology and/or chemistry; consent of instructor. BRYANT, WOLIN.

490. **Dairy Science Seminar.** Current literature relating to various phases of dairy science. ½ unit. Prerequisite: Graduate major or minor in dairy science. SALISBURY.

493. **Special Problems.** Individual investigations in any phase of dairy science. ½ to 2 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, DEFRIES, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

499. **Thesis Research.** 0 to 4 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, DEFRIES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** Supervised research on any phase of dairy science, including bacteriology and microbiology, biochemistry, feeding and nutrition, genetics, and physiology. ½ or 1 unit. Prerequisite: Approval of head of department. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, DEFRIES, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

305. **Genetics and Animal Improvement.** Same as Animal Science 305. The principles of heredity and their application to the problem of animal improvement. ¾ unit. Prerequisite: Dairy Science 110 or equivalent. DEFRIES, RASMUSEN, TOUCHBERRY.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. GRAVES, LODGE.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or Marketing 101 or twelve hours of dairy science or dairy technology. BARTLETT.

381. **Dairy Biochemical Laboratory Methods.** Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, microrespiration, and others. 1 unit. Prerequisite: Quantitative analysis; organic chemistry; consent of instructor. Biochemistry is recommended. BROQUIST, LARSON.

DANCE

The Dance Division offers a program of graduate study leading to the Master of Arts in Dance. This program offers advanced work in choreography, dance production, and pedagogy, with emphasis on the related fields of art, music, and theatre, and is administered by the supervisor of the Dance Division and an interdisciplinary committee composed of representatives from the Department of Art, the Department of Speech and Theatre, and the School of Music.

Admission requirements for a major in this field are: (1) a minimum grade-point average of 3.5; (2) twenty-four semester hours of approved undergraduate credit in dance (at least eight hours), art, music, theatre, and physical education; (3) thirty-six semester hours in humanities (literature, language, and philosophy), natural sciences (biological and physical sciences), and social sciences (history, political science, psychology, anthropology, sociology, education). Applicants lacking a portion of the prerequisites under item (2) may substitute certified experience in dance not to exceed eight semester hours.

Satisfaction of the general requirements for admission to the Graduate College and to this program does not in itself necessarily qualify the student as a degree candidate. The supervisor of the Dance Division also reserves the right to accept for advanced study only those students whose preparation in dance has been obtained in certain approved institutions.

Of the eight units required for the Master of Arts, a minimum of four must be in dance, or (subject to the approval of the supervisor) in dance and related areas such as art, music, theatre, speech, physical education, and recreation; two units must be in one or more of the following fields: English, history, philosophy, anthropology, psychology, sociology, radio-television. The remaining two units are for the presentation of an acceptable thesis (Dance 499) and the accompanying noncredit course, Dance 490, Seminar. The thesis may be waived, with the approval of the adviser, but in lieu thereof the candidate must submit two units of course work (total of eight units), plus a recital of solo and group dances which he has choreographed and staged.

Not later than midpoint in the student's program, his work is reviewed in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The supervisor of the Dance Division may extend the residence requirement (or increase the total requirements) at this time or any other time, if this seems warranted.

GRADUATE FACULTY

Professor: Margaret Erlanger (Supervisor of Dance Division).

Assistant Professor: W. W. Ward, Jr.

COURSES FOR GRADUATES

400. **Problems in Dance Education.** Basic historical, philosophical, and scientific foundations and developments in dance education; teaching methods; development of compositional problems; creative methods of instruction; organizational problems of dance groups and public dance performance. 1 unit. Prerequisite: Dance 243 or 244, or equivalent. Erlanger.

401. **Choreography.** Experience in choreographing a minimum of a solo and a group composition to be presented at the end of the semester. ½ to 2 units. Prerequisite: Dance 345 or equivalent. Students may re-register for a maximum of two units with the permission of the supervisor of the Dance Division. Ward.

490. **Dance Seminar.** Student presentation of thesis reports in dance. Informal discussions, demonstrations, lectures, and critical analysis of current problems in dance by professional guests. No credit. Staff.

499. **Thesis Research.** Preparation of thesis in dance. ½ to 2 units. ERLANGER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **History of Dance.** A survey course tracing dance from its beginnings in primitive societies to its present art form. ½ unit. Prerequisite: Consent of instructor. ERLANGER.

345. **Dance Production Workshop.** Experience in choreography and production of group compositions with special emphasis on staging, lighting, and costuming. ½ unit. Prerequisite: Dance 164 or equivalent; consent of instructor. WARD.

346. **Theory and Philosophy of Dance.** A study of the relationship of aesthetic principles and dance theory to a philosophy of dance in education and of dance as a performing art. ½ unit. Prerequisite: Consent of instructor. ERLANGER.

ECONOMICS

The Department of Economics offers graduate work leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

A student who applies for admission to graduate study in economics must have a grade-point average of 4.0 or higher. Students with averages between 3.75 and 4.0 are considered on an individual basis. Applicants must have completed fifteen hours of undergraduate work in economics or have approval of the Director of Graduate Studies. The department requires that the results of the Graduate Record Examination Aptitude Test accompany application for admission to the Graduate College, except that under unusual circumstances the student may secure permission from the Department of Economics to take this examination during his first semester of residence. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, 22 Nassau Street, Princeton, New Jersey.

The candidate for an advanced degree in economics may specialize in one of the following areas of economics: economic theory, history of economic thought, income theory and policy, monetary theory and policy, public finance and taxation, growth and development economics, international economics, mathematical economics, labor economics, economic history, comparative economic systems, business cycles and forecasting, transportation, economic statistics, econometrics, operations analysis, economic education, and relations of government and business.

Master of Arts or Master of Science. The following requirements must be met:

(1) Economic Theory. Two units of course work, consisting of 400-401, or 402-403; if the student has had 300-301 or their equivalent, he must take 402-403.

(2) Statistics. Proficiency in statistical analysis. This requirement may be met by taking Economics 470 or 471, an equivalent graduate course at another institution that is approved by the Director of Graduate Studies, or a proficiency examination.

(3) History of Economic Thought or Economic History. One unit in either field at the 400 level. Two units are recommended.

(4) Course work beyond those required to bring the total to eight units, two of which may be master's thesis work.

(5) Satisfactory completion of a master's thesis, or successful completion of the Ph.D. preliminary examinations.

Doctor of Philosophy. The following requirements must be met:

(1) Economic Theory. Economics 402-403, plus one additional course in economic theory at the 400 level.

(2) Statistics. Demonstration of proficiency in the same manner as for the master's degree.

(3) History of Economic Thought and Economic History. Passing a written preliminary examination in these subjects with one unit of course work in each at the 400 level.

(4) Specialized Fields. The student must select three additional fields, two of which must be in economics, and the third outside the department. At least two units of graduate work in courses in each field selected are required.

(5) Additional units to bring the total to twenty-four, of which eight must be doctoral dissertation units.

The candidate is required to pass examinations in two foreign languages, an oral and written preliminary examination prior to beginning dissertation research, and an oral final examination covering his research.

GRADUATE FACULTY

Professors: J. F. Due (Chairman of Department), V L. Bassie, J. F. Bell, R. Brandis, H. J. Brems, W. E. Chalmers, R. Ferber, D. P. Flanders, M. Frankel, H. M. Gray, R. W. Harbeson, D. R. Hodgman, D. L. Kemmerer, E. B. McNatt, W. H. McPherson, W. A. Neiswanger, D. W. Paden, J. B. Parrish, J. D. Phillips.

Associate Professors: Grace Beckett, R. W. Gillespie, W. W. McMahon, H. O. Nourse, F. R. Shupp, C. M. Sprenkle, P. Wells, Janet L. Weston, T. A. Yancey.

Assistant Professors: D. J. Aigner, J. D. Bowman, F. M. Gottheil, D. A. Markwalder, R. W. Resek, S. W. Steinkamp.

COURSES FOR GRADUATES

400. General Economic Theory. Emphasis in this course is placed on micro-economic theory. The principal topics include: a review of value and distribution theory, the theory of choice by households and firms, general micro-economic theory, and theoretical developments of current interest. Attention is given to empirical studies intended to affirm or disaffirm economic principles. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders.

401. General Economic Theory. Emphasis in this course is placed on macro-economic theory and the relationship of economics to the other social sciences. The principle topics include: a review of Keynesian macro-economic theory. formal growth theory, selected business cycle theory, the theory of socio-economic change, and an outline of the differentiation and integration of economics and other social sciences. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders.

402. Economic Theory. This course develops modern micro-economic theory: utility functions and demand; production functions and cost; linear programming; price and nonprice policy by the firm; market equilibria; income distribution; general equilibrium including input-output analysis. The course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus.

403. Economic Theory. This course develops modern macro-economic theory; the Keynesian model of employment, interest, and money; its extension to international trade; fiscal policy and macro-economic theory of distribution; the consumption function; the theory of growth and cycles in terms of difference and differential equations. This course is given in two sections, one offering

a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus.

406. **History of Economic Thought.** A study of the origins and development of economic thought from early times to mid-nineteenth century. Factors are considered that aid in the growth of states and the subsequent policies of mercantilism and physiocracy. Classical economics and economists are emphasized. 1 unit. BELL.

407. **History of Economic Thought.** The study begins with Socialist doctrines and covers the development of marginal utility, neoclassical, and Keynesian analyses and more recent contributions to economic thought. 1 unit. BELL.

410. **Price and Distribution Theory.** A research-oriented seminar in micro-economic theory. Major topics treated include: comparative static analysis of demand, production, and the theory of markets; dynamic equilibrium; market dynamics. Sub-topics include axiomatics of preferences; ordinal and Bernoullian utility, revealed preference, and the interdependence of preferences; multiperiod production, utility, and consumption; the aggregation of micro-economic relationships; expectations and response lags; analysis of changing market structures; game theory. 1 unit. Prerequisite: Economics 402 and 470, or equivalent. AIGNER.

411. **Capital and Interest Theory.** A comprehensive and critical examination of the theory of capital and interest as the subject has been developed by the leading English and continental writers. Special attention is given to the optimal investment decision of the firm, capital accumulation and the efficient utilization of society's resources, and to the relation between capital and interest. 1 unit. Prerequisite: Economics 403 or consent of instructor. WELLS.

412. **Theory of Aggregate Income.** A comprehensive introduction to the theory of income and employment with emphasis upon fluctuation and growth. 1 unit. PADEN.

413. **Consumption Theory.** The theory of consumer behavior in modern economic analysis. Utility analysis at the micro level, consumer interdependence and problems of aggregation, econometric tests, aggregate consumption analysis in static and dynamic contexts, and the implications of the theory of consumer behavior for cyclical movements and economic growth. 1 unit. Prerequisite: Economics 400 or 402 or consent of instructor. MCMAHON.

414. **Public Finance.** An analysis of the economics of public expenditures, administration of public funds, intergovernmental fiscal relations, nontax revenues, public borrowing, debt management, and fiscal policy. 1 unit. Prerequisite: Six hours of economics. DUE.

415. **Economics of Taxation.** An analysis of the economics of taxation, with respect to distribution of tax burden, incidence of taxation, and the place in the tax system of the major taxes, particularly the personal and corporation income, sales and excise, property, and death taxes. 1 unit. Prerequisite: Six hours of economics. DUE.

420. **Monetary Theory.** A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the quantity theory, liquidity preference, the demand for money, velocity, theories of the level and term structure of interest rates, asset theory, and money in static and dynamic macro-general equilibrium models. 1 unit. Prerequisite: A course in income and employment theory or consent of instructor. HODGMAN.

421. **The Theory of Monetary Policy.** Theories of central banking, debt management, financial intermediaries, and the monetary behavior of firms and households are used to explore current issues in the theory of monetary policy. Current empirical research is reviewed with particular emphasis on econo-

metric studies of monetary behavior. 1 unit. Prerequisite: A course in money and banking, in macro-economic theory, calculus, and statistics, or consent of instructor. HODGMAN.

425. **Macro-Accounting.** Same as Accountancy 455. An examination of the fundamental concepts underlying the attempt to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor.

428. **International Trade Theory.** The neoclassical theory of international trade is developed and then used for the analysis of tariffs, customs unions, and the effects of trade on the distribution of income and welfare. The relations between the balance of payments and national income are analyzed and used to study the role of income changes combined with price changes in the balance of payments adjustment process. 1 unit. Prerequisite: Economics 300 and 301. or equivalent. GILLESPIE.

429. **International Trade Policy.** Concepts of balance of payments equilibrium, the foreign exchange market and the theory of capital movements; current problems and policies related to balance of payments disequilibrium, trade policy, and the functioning of the international monetary system. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. GILLESPIE.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, foreign and domestic commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 236. 1 unit. KEMMERER.

438. **Economic History of Europe.** The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, and industrialization, etc. 1 unit. Prerequisite: Consent of instructor.

440. **Labor Economics.** Same as Labor and Industrial Relations 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

441. **Labor Economics.** Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

442. **Collective Bargaining.** Same as Labor and Industrial Relations 442. The development of a theory of the continuing interactions between unions and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and governmental process. 1 unit. Prerequisite: Consent of instructor. CHALMERS.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Labor and Industrial Relations 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling, analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. McPherson.

444. **Economics of Manpower Resources.** Same as Labor and Industrial Relations 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. Parrish.

447. **Labor Union Organization and Administration.** Same as Labor and Industrial Relations 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. Garman.

450. **The Economics of Development and Growth.** Review and analysis of both the facts and the theories of growth in developed and underdeveloped economies. The problems and methods of measuring growth are considered, the variables thought to be strategic in the growth process are critically examined, and the policy implications of different theories are explored. 1 unit. Prerequisite: Economics 300 and 301 or consent of instructor. Frankel.

451. **The Developing Economies.** An analysis of the newly-developing economies, with emphasis on institutional factors affecting development, and economic policy relating to development. 1 unit. Prerequisite: Economics 300 or consent of instructor. Economics 450 recommended. Due.

455. **Comparative Economic Systems.** A comparative analysis of the structures and policies of market-directed and planned economies. 1 unit. Prerequisite: Economics 103 or 108 or equivalent. Gottheil.

467. **Economic Activity Analysis.** Selected topics in economic theory are analyzed with the aid of mathematical programming, input-output analysis, set theory, and game theory. Existence, optimality and stability conditions for static and dynamic general equilibrium phenomena are emphasized, and such related topics as welfare economics and capital accumulation may be treated. 1 unit. Prerequisite: Consent of instructor.

468. **Economic Dynamics.** The course is devoted to the study of the behavior of the aggragate output and income over time. Mathematical models are dedeveloped of long-run growth and short-run cycles, as well as the interaction between the two. Familiarity with first-order, second-order, and higher order single difference equations as well as systems of difference equations is acquired in the course; it is not a prerequisite. 1 unit. Prerequisite: Economics 403. Brems.

470. **Economic Statistics.** Classical statistics and regression analysis; descriptive statistics, probability, point and interval estimation, decision theory, variance analysis, linear regression and least squares estimates. 1 unit. Prerequisite: Consent of instructor. Neiswanger.

471. **Economic Statistics.** Part 1. The construction of econometric models; characteristics of models and choice of estimating methods; estimates of parameters by various methods. Part 2. Bayesian statistics and decision theory. 1 unit. Prerequisite: Economics 470 or equivalent. NEISWANGER.

472. **Econometrics.** Same as Mathematics 472. Point estimates of parameters for systems of simultaneous equations; properties of various estimators; hypothesis testing and confidence intervals for econometric models. 1 unit. Prerequisite: Mathematics 363 and 315 or consent of instructor. NEISWANGER, YANCEY.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information, selecting critical factors, and appraising the validity of analytical techniques. 1 unit. Prerequisite: Economics 170 and 312 or 373 or equivalents. BASSIE.

474. **Operations Research.** A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, dynamic programming, queuing theory, renewal theory, and simulation methods are applied to economic control systems with special emphasis on the problems of the firm. 1 unit. Prerequisite: Mathematics 363 and Economics 374 or equivalent. SHUPP.

479. **Research Seminar in Quantitative Economics.** Significant work in the area of quantitative economics is reported and explored by members of the instructional staff, by guest speakers from academic, governmental, and industrial centers, and by graduate students in the second year of their work who are assigned projects. 1 unit. Prerequisite: The equivalent of one year of graduate statistics (theoretical or applied), calculus, and the equivalent of one year of mathematical economics. FERBER.

480. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit. GRAY.

481. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit. GRAY.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. LOCKLIN.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. LOCKLIN.

490. **Individual Study and Research.** Directed reading and research ½ to 1 unit. STAFF.

499. **Thesis Research.** Required of all students writing master's and doctor's theses in economics 0 to 4 units. Master's theses, FLANDERS; doctor's theses, BELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Intermediate Microeconomic Theory.** Microeconomic analysis including value and distribution theory. Topics include the analysis of demand, the theory of the firm and the industry, and the analysis of the pricing of the factors of production. Each topic is integrated in a micro general equilibrium context which builds towards explaining the resource allocation process. ½ unit. Prerequisite: Economics 103 or 108. Students may not receive credit for both Economics 200 and 300. MCMAHON.

301. **Intermediate Macroeconomic Theory.** The modern theory of the determination of the level and rate of growth of income, employment, output, and the

price level. Alternate fiscal and monetary policies to facilitate full employment and economic growth are discussed. Prerequisite: Economics 103 or 108. ½ unit. SPRENKLE, WELLS.

302. **Economic Analysis.** An introduction to the theory of income and employment, price and allocation, and instability and growth. S; ½ or 1 unit. Prerequisite: Economics 108, enrollment in National Science Foundation Summer Institute in Economics, or consent of instructor. PADEN.

306. **History of Economic Thought.** A study of the development of economics Contributions of schools of thought and individual writers are examined in their settings and as they influenced economic thought and national policy. ½ unit. Prerequisite: Economics 103 or 108. BELL, GOTTHEIL.

312. **Economic Dynamics and Growth.** An analysis of the causes of economic instability; the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. ½ or 1 unit. Prerequisite: Economics 108, or 103 and 301.

313. **Economics of Consumption.** Same as Home Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics.

329. **International Trade Policy.** Analysis of the trade policies of selected countries, with particular reference to the United States; study of the relationships between international trade policy and the theory of international trade and finance. ½ or 1 unit. Prerequisite: Economics 103 or 108. BECKETT.

335. **American Financial History.** American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banking and of other financial institutons, and the financing of government, especially of major wars. ½ or 1 unit. Prerequisite: Finance 250. KEMMERER.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history.

342. **Economics of Social Security.** Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108. MCNATT.

343. **Collective Bargaining.** Emergence of collective bargaining in American industry, national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. ½ or 1 unit. Prerequisite: Economics 240. PARRISH.

344. **The Law and Labor.** Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240. MCNATT.

349. **Senior Seminar in Labor Economics.** Pre-professional capstone course intended to unify other courses in labor economics and closely related fields. Included are studies of research techniques and sources; individual readings in current

literature; preparation of research reports and papers; consideration of professional employment opportunities and graduate study in labor economics and industrial relations. ½ or 1 unit. Prerequisite: Economics 240 and consent of instructor. PARRISH.

352. **Economic Development in Latin America.** A study of economic activity and the process of diversification and industrialization in Latin America, with comparative analysis of selected countries. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. BECKETT.

357. **The Soviet Economy.** Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. HODGMAN.

360. **Regional Economic Development.** A survey of the theory and problems of regional economic development, including regional accounts, interregional income and trade theory, principles of the location of economic activity, theories of regional growth, and public policy for development of regions. ½ or 1 unit. Prerequisite: Economics 103 or 108. NOURSE.

366. **Mathematical Analysis in Economics.** This course is designed to acquaint the student with the application of mathematical techniques to economic theory, especially general equilibrium theory. ½ or 1 unit. Prerequisite: Economics 103 or 108; some knowledge of calculus.

371. **Sampling Theory and Technique.** Design of samples useful in economic and business research. Problems considered relate to the efficiency of sample designs, cost limitations, bias, non-sampling errors, and interpretation of results. Sampling theory is applied to specific sampling problems through the use of electronic computers. ½ or 1 unit. Prerequisite: Economics 173 or equivalent. AIGNER.

373. **National Income and Business Forecasting.** The development of the national income accounts and their use in forecasting business conditions. Forecasting for the economy as a whole and for the individual industry or firm. The construction and use of economic models in forecasting. ½ or 1 unit. Prerequisite: Economics 103 or 108, and Economics 173. NEISWANGER.

374. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of linear programming and dynamic programming, game theory, probability theory, queueing theory, and inventory theory. ½ or 1 unit. Prerequisite: Economics 170 and Industrial Administration 101, or consent of instructor. RESEK.

384. **Economics of Transportation.** Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. ½ or 1 unit. Prerequisite: Economics 103 or 108.

385. **Economic Problems of Commercial Air Transport.** Study of air transport with particular reference to questions of public policy, system of regulation, and regulatory policy. ½ or 1 unit. Prerequisite: Economics 103 or 108.

386. **Current Transportation Problems.** An analytical and critical study of selected problems of current interest in transportation. ½ or 1 unit. Prerequisite: Economics 384. HARBESON.

389. **Industrial Competition and Monopoly.** The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

EDUCATION

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology (including a special program in psychology of classroom learning and instruction), elementary school teaching, guidance and counseling (including rehabilitation counseling), history and philosophy of education, measurement and evaluation, research methods, school psychology, or any of the fields of secondary school education: English, home economics, industrial education, mathematics, modern languages, science, and social science.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher (see page 18), and undergraduate preparation appropriate to advanced study in the chosen major. Applicants who hold bachelor's degrees in fields other than teacher education will be considered on an individual basis. See admission requirements for the Master of Education.

Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College (see pages 18 to 23), the following regulations apply to programs leading to the Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of not more than two units is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312 are required.

Master of Science in the Education of the Deaf. One of the following is necessary for admission: (1) a bachelor's degree in elementary or special education (other than education of the deaf), or (2) a bachelor's degree in education of the deaf from an accredited training center for teachers of the deaf.

Candidates for this degree must earn a minimum of eight units as follows:

(1) History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312.

(2) For students qualifying under requirement (1) Special Education 417, one unit; Special Education 319, one or one and one-half units; Special Education 320, one to two units; Speech 301, one-half unit; Speech 385, one-half unit; and Speech 395, one-half unit, are required. For students qualifying under requirement (2), Special Education 418, one unit, and Special Education 449, one unit.

(3) Electives chosen from Vocational and Technical Education 381; Educational Psychology 412, 425, 426; Educational Administration 430, 440, 460; Secondary Education 456; Psychology 443, 461; Speech 375, 388, 488, 489.

The advisers for candidates for this degree are Professors Samuel A. Kirk, James J. Gallagher, and Stephen Quigley.

Master of Science in the Education of Mentally Handicapped Children. The following are required for admission: courses sufficient to meet the requirements for an Illinois Teacher's Certificate and Special Education 220, Elementary Education 231, and Speech 208.

Candidates for this degree must earn a minimum of eight units as follows:

(1) Required courses: History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312; Special Education 322, 323, 417; and Educational Psychology 426.

(2) Elective courses chosen from Educational Psychology 390, 411, 412; Elementary Education 433; Psychology 338, 406, 411, 445, 461, 467, 493, 494; Speech 385, 388.

The advisers for candidates for this degree are Professors Samuel A. Kirk, James J. Gallagher, Robert A. Henderson, and Laura J. Jordan.

Doctor of Philosophy. The general requirements of the Graduate College pertaining to the Doctor of Philosophy must be met. (See pages 23-25.) To become a candidate for the Doctor of Philosophy with a major in education, the applicant must hold a master's degree with a major in education or some appropriately related subject. An applicant who has not written a master's thesis will be required to prepare and submit a paper equivalent to a master's thesis. The applicant should present credentials well in advance of his first registration. Required examinations and other steps preliminary to admission must be completed prior to the registration period. Admission is not complete until the student has been accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Applicants holding bachelor's degrees in fields other than teacher education may be considered individually for admission to the program leading to the Master of Education. Applicants admitted with deficiencies in professional education or for teacher certification will be required to take a limited number of undergraduate courses. Such courses will not be counted in the eight units of graduate work required for the Master of Education.

In general, the professional education requirements for the Master of Education and for teacher certification may be fulfilled through proficiency examination in Educational Psychology 211, an appropriate methods course at the undergraduate level, student teaching, History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. However, an applicant admitted with deficiencies should expect to take additional courses in the teaching subject fields.

Those preparing for teaching at the secondary level must have completed a minimum of thirty-two semester hours of appropriate course work in the first teaching field, and from twenty to twenty-four semester hours of credit in a second teaching field. Previous course work in such fields will be evaluated and considered in determining the eligibility of a student for teacher certification.

Graduate students admitted with deficiencies for teaching in the elementary schools will be required to complete Illinois teacher certification requirements through appropriate undergraduate and graduate course work.

The advisers of students admitted with deficiencies will develop programs in which a maximum number of teacher certification requirements are met through courses also acceptable in fulfillment of master's degree requirements. Students admitted with no deficiencies can complete requirements for the Master of Education through full-time study in two semesters. However, students admitted with deficiencies for certification should anticipate from one to two additional semesters of course work.

Program. At least eight units of course work, including four units in education, are required. History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312 are required, except from students who pass proficiency examinations in these courses.

There may be one or two minors. In general, candidates for the Master of Education are expected to take at least two units in fields other than education, particularly if the specialization is in secondary education. One unit at the 300 level in the teaching subjects (s) may be substituted for one of the three units at the 400 level otherwise required. Courses at the 200 level in the teaching subject (s) may be taken for graduate credit subject to the prior approval of the Dean of the Graduate College, but total credit in such courses may not exceed two units. Credit earned in such courses cannot be applied to the requirements for the Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Residence. At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years' successful professional employment in education are required.

Program. A year of specialized professional study is required. Of the eight units of course work required, at least four must be in courses at the 400 level. Students who have not previously taken History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312, or equivalents, must take them or pass proficiency examinations. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education. The program must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy.

Residence. The residence requirement is similar to that for the Master of Education.

Doctor of Education. Programs leading to the Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Applicants for admission should present credentials well in advance of the date for their first registration. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Program. Sixteen units of course work beyond the master's degree are required. Extramural course work may not be included in this sixteen-unit requirement. (Exceptions may be made for Educational Psychology 413 and Educational Administration and Supervision 461, 462, and 463.) A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

History and Philosophy of Education 410 and Educational Psychology 415 and 496 are required (note prerequisites).

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his

admission and must pass a comprehensive written examination before he may enter the oral preliminary examination.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

The thesis required for the Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the examinations, filing of thesis titles, and the preparation, submission, and publication of theses must be met.

Residence. Minimum residence requirements are (a) two consecutive semesters, at least three units each, or (b) one semester, at least three units, and the summer session immediately preceding or following, at least one and one-half units, plus an additional summer session, at least one and one-half units.

Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 265.

GRADUATE STUDY IN SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an intern. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program are subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

GRADUATE STUDY IN CLASSROOM LEARNING AND INSTRUCTION

Students planning to specialize in research and/or collegiate instruction in the educational psychology of classroom learning and instruction may become candidates for either the Doctor of Philosophy or the Doctor of Education. Doctor of Philosophy candidates major in education and minor in psychology or take a split minor with psychology and a related area, such as communications, or a subject such as mathematics, chemistry, or social studies. The program of study for the doctorate degree requires a minimum of three years of graduate study, including six months of internship. After an applicant is admited, his study program is subject to review by one of the advisers associated with the program. A required core program consists of Educational Psychology 412, 449, 490, 492, 496, 497, and Psychology 418 and an internship of six months' minimum duration. The doctoral dissertation is generally written in the area of the nature, conditions, and improvement of classroom learning and instruction.

GRADUATE FACULTY

Professors: R. N. Evans (Dean of College of Education), C. M. Allen, A. W. Anderson, E. W. Anderson, J. M. Atkin, D. P. Ausubel, F. P. Barnes, M. Beberman, G. M. Blair, H. S. Broudy, R. W. Burnett, J. J. DeBoer, F. H. Finch, J. J. Gallagher, N. E. Gronlund, J. T. Hastings, S. P. Hencley, K. B. Henderson, D. M. Jackson, R. S. Jones, M. R. Karnes, W. V. Kaulfers, G. C. Kettelkamp, Colleen J. Kirk, S. A. Kirk, C. G. Knapp, A. H. Krebs, L. E. McCleary, J. E. McGill, W. P. McLure, L. E. Metcalf, P. V. Miller, W. J. Moore, T. E. Newland, M. M. Ohlsen, C. H. Patterson, L. J. Phipps, R. E. Pingry, F. C. Proff, C. W. Sanford, H. A. Schultz, J. H. Shores, R. H. Simpson, B. O. Smith, W. O. Stanley, Celia B. Stendler, L. M. Stolurow, J. R. Suchman, M. R. Sumption, L. R. Tucker.

Associate Professors: M. D. Baughman, C. E. Bereiter, W. C. Bonney, J. R. Burnett, F. L. Crank, T. E. Culliton, L. A. Fisher, J. G. Froehlich, O. E. Gould, P. E. Hemp, R. A. Henderson, K. M. Lansing, D. G. Lux, T. Manolakes, Mary Mather, C. J. McIntyre, F. McMurray, J. R. Palmer, H. Quay, S. P. Quigley, V. E. Ricks, W. L. Shoemaker, Elizabeth Simpson, J. M. Slater, R. E. Stake, M. Tatsuoka, R. A. Tinkham.

Assistant Professors: R. C. Anderson, Barbara Bateman, E. C. Bernos, T. H. Boardman, J. D. Boney, A. L. Brophy, J. Chaltas, G. A. Chambers, R. J. Colwell, W. H. Evans, G. R. Fuller, C. M. Garverick, J. C. Horger, Laura J. Jordan, H. Kaczkowski, F. H. Klassen, Jean Phillips, B. Reimer, W. J. Schill, Hazel Spitze, R. M. Tomlinson, C. J. Van Horn, J. R. Warmbrod.

Educational Administration and Supervision

COURSES FOR GRADUATES

430. **Elementary School Organization and Administration.** Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the elementary school. Examination is made of administrative roles in the design, implementation, and improvement of the total educational program. Intensive use is made of research skills and strategies in the investigation of problems of instruction. 1 unit. Prerequisite: Consent of instructor. Barnes, McGill, Springer.

438. **Instructional Supervision.** Methods, theories, and research applying to supervision at all levels of public education. Analyses are made concerning the work of curriculum directors, general supervisors, special supervisors, supervising principals, and department heads. Study of supervisory methods, current plans for staff utilization, use of instructional materials, evaluation of educational programs, and evaluation of the effects of supervision are stressed. 1 unit. Prerequisite: Elementary Education or Secondary and Continuing Education 439. Barnes, Baughman, McGill.

440. **Administration and Supervision of Junior and Senior High Schools.** Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the secondary schools. Problems are then projected through case studies and situational descriptions as a means of examining tasks and processes in such areas as curriculum and instruction, pupil and staff personnel, student activities, school organization and management, and school-

community relationships. 1 unit. Prerequisite: Educational Administration and Supervision 460 or consent of instructor. BAUGHMAN, HENCLEY, MCCLEARY.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

460. **Public Control and Administration of Education.** A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective administrative officers and supervisors. Not open to experienced administrators nor to students who have taken any of the following courses (or equivalents): Educational Administration and Supervision 430, 440, 461, 462, 464, 465, 466. 1 unit. CHAMBERS, HENCLEY, MILLER, SPRINGER.

461. **Administration of Educational Programs and Personnel.** Study of principles and criteria for analysis of programs at various levels of operation, such as instructional departments and pupil personnel service units, individual schools, local school systems, intermediate units, state education departments, and the federal government. Similar study is given to analysis of personnel requirements at various levels of operation. Educational Administration and Supervision 461, 462, and 463 constitute the required core program for all students specializing in educational administration who are candidates for a degree beyond the master's. 1 unit. Prerequisite: Educational Administration and Supervision 460 and 430 or 440. MCCLEARY, MILLER, SPRINGER.

462. **Financial and Operating Structures of Public Education.** Study of relations of public education to the national economy; organization and operation of public school government; an analysis of theory and practice in school finance; processes of managing business affairs; role of law in school administration; and methods of survey, evaluation, and planning. 1 unit. Prerequisite: Educational Administration and Supervision 460; 430 or 440; 461. CHAMBERS, MCLURE.

463. **The Role of Administrative Leadership.** Study of principles underlying administrative leadership drawn from such disciplines as philosophy, psychology, sociology, and public administration. Application of these principles in the analysis and formulation of general procedures by which the process of administration may be carried on most effectively to develop and operate efficient educational programs. 1 unit. Prerequisite: Educational Administration and Supervision 460; 430 or 440; 462. HENCLEY, MCCLEARY, MILLER.

464. **Field Problems in Educational Administration.** Designed to give direct experience in the study of educational problems of concern to administrators. Each student selects and pursues one or more problems of study under the supervision of a professor. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

465. **Public School Finance and Business Administration.** The theory and practice of financing public education in the United States; development of guiding principles in educational finance, trends and needs in state and federal participation in school support, and local operational finance. Not open to students who have completed Educational Administration and Supervision 461 or 462. 1 unit. Prerequisite: Educational Administration and Supervision 460. MCLURE, MILLER.

466. **Public School Finance.** Advanced graduate study of the theory and technology of public school finance. Attention is centered on analysis of principles

and theory underlying fiscal practice in various states; technical knowledge of designing controls, organization, and fiscal systems in harmony with expressed theory; and the application of research to the analysis of problems related to the improvement of financing public schools. 1 unit. Prerequisite: Educational Administration and Supervision 460; 430 or 440; 462. McLure.

468. **School-Community Relations.** Study of the relationship of the American school to the community. Analysis of the power structure, social agencies, school liaison groups, and economic character of the community as they affect and are affected by the school. Includes an evaluation of the various media of communication between the school and the larger community, and the development of criteria for an effective program of school-community relations. 1 unit. Springer, Sumption.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupil, parents, teachers, administrators, and school board members in relation to the school. 1 unit. Sumption.

470. **Principles and Resources for School Plant Planning.** Study of principles for planning functional school buildings. Primary emphasis is placed on the planning process involved in meeting the building needs of the school district, including (1) analysis and projection of educational programs to be housed, (2) prediction of pupil enrollments, (3) site selection, (4) educational specifications of buildings, and (5) rehabilitation, remodeling, and modernization of existing buildings. 1 unit. Prerequisite: Educational Administration and Supervision 460. Chambers.

490. **Seminar for Advanced Students of Education.** Seminar in educational administration and supervision open only to persons who have been admitted to candidacy for the Doctor of Philosophy or Doctor of Education and who have completed the preliminary examination. 1 to 2 units. Staff.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. Staff.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. Staff.

Educational Psychology

COURSES FOR GRADUATES

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundation, and its implications for education. 1 unit. Prerequisite: Educational Psychology 311 and 312. Ausubel, Blair, Bonney, Jones

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the preschool and elementary school years, with emphasis on development as a process of social learning; interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. 1 unit. Prerequisite: Educational Psychology 311 and 312. Ausubel, Garverick, Jones, Stendler.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional

functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. 1 unit. Prerequisite: Educational Psychology 311 and 312. R. H. SIMPSON.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. Psychoeducational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis and use of test results and resource materials in this field. 1 unit. Prerequisite: A course in psychology; consent of instructor. GARVERICK, R. H. SIMPSON.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. 1 unit. Prerequisite: Educational Psychology 311 and 312; Educational Psychology 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR, JONES.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. 1 unit. Prerequisite: Educational Psychology 311 and 312. BONNEY, BROPHY, OHLSEN, PROFF, SHOEMAKER, SLATER, TOTH.

423. **The Use of Tests in Guidance.** Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. 1 unit. Prerequisite: Educational Psychology 392. BONNEY, BROPHY, HASTINGS, PATTERSON, PROFF.

424. **Supervised Practice in Counseling.** Study of the individual client through the use of the tools of the counselor. Each student is expected to develop professional skills by working with clients. 2 units. Prerequisite: Master's degree in guidance and consent of faculty committee. STAFF.

425. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Educational Psychology 325 are not given credit for Educational Psychology 425. 1 unit. STAFF.

426. **Diagnostic and Remedial Programs of the School.** A study of remedial programs in reading, spelling, English, arithmetic, handwriting, and content subjects. 1 unit. Prerequisite: A basic course in the teaching of reading and consent of instructor. CULLITON, W. EVANS, POWELL, WALKER.

427. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. 1 unit. Prerequisite: Educational Psychology 311, 312, 422, 423, and either 325 or 425; or consent of instructor. BONNEY, OHLSEN.

428. **The Analysis and Use of Occupational Information in Guidance Programs.** Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. 1 unit. Prerequisite:

Educational Psychology 325 or 425, or consent of instructor. BROPHY, OHLSEN, SHOEMAKER.

429. **Field Instruction in Counseling.** Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. 1 or 2 units. Prerequisite: Educational Psychology 422 and 424 (with consent of instructor, registration in Educational Psychology 424 may be concurrent). STAFF.

447. **Seminar in Rehabilitation Counseling.** Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publications. May be repeated for a maximum of one unit. ½ unit. Prerequisite: Educational Psychology 326 and 422. PATTERSON, TOTH.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in educational psychology open only to persons who have been admitted to candidacy for the Doctor of Philosophy or Doctor of Education and who have completed the preliminary examination. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

492. **Psychology of Learning and Instruction.** Same as Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON, STOLUROW.

494. **Multivariate Analysis in Psychology and Education.** Same as Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER.

495. **Theory of Measurement.** Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307 or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. HASTINGS, KAISER, TUCKER.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and

the testing of statistical hypotheses; and other applications of statistics to educational research. 1 unit. Prerequisite: Educational Psychology 390. PINGRY, STAKE, TATSUOKA, VAN HORN.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Analysis of variance and co-variance, experimental design, introduction to multivariate statistical techniques including discriminant analysis. 1 unit. Prerequisite: Educational Psychology 496. TATSUOKA.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. 1 unit. Prerequisite: Educational Psychology 496. HASTINGS, STAKE.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understanding. ½ unit. Prerequisite: Educational Psychology 211, and practice teaching or teaching experience. BLAIR, GARVERICK, JONES, R. H. SIMPSON.

312. **Mental Hygiene and the School.** An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. ½ unit. Prerequisite: Educational Psychology 211 and practice teaching or teaching experience. GRONLUND, JONES, TOTH.

325. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in schools; what the teacher can do in guidance. Students may not register for credit in both Educational Psychology 325 and 425. ½ unit. Prerequisite: Eight semester hours in education and psychology. BONNEY, OHLSEN, PROFF, SLATER.

326. **Introduction to Vocational Rehabilitation Counseling.** A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and problems of vocational rehabilitation counseling. ½ unit. Prerequisite: Consent of instructor. PATTERSON, TOTH.

343. **Individual Intelligence Testing.** The fundamental concepts relevant to the general problem of the individual testing of learning aptitude. Acquisition of psychometric competence in the use of the 1960 Binet and the Wechsler tests. Acquaintance and limited practice in the administration, scoring, and interpretation of results obtained by means of performance scales and other devices appropriate for use with individuals having sensory, associative, and/or motor impairments. 1 unit. Prerequisite: Six hours of psychology and Special Education 324 or Educational Psychology 392 or Psychology 290, or equivalent. NEWLAND.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graduate work,

and for introductory value for students continuing graduate study in education. The course includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. 1 unit. HASTINGS, PINGRY, STAKE, TATSUOKA, VAN HORN.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. 1 unit. Prerequisite: Educational Psychology 211. GRONLUND, HASTINGS.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. 1 unit. Prerequisite: Educational Psychology 211. GRONLUND, HASTINGS, STAKE, VAN HORN.

Elementary Education

COURSES FOR GRADUATES

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. 1 unit. STAFF.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the following fields: (a) language arts, (b) social studies, (c) arithmetic, (d) science, (e) creative arts. 1 unit. Prerequisite: For all sections, Elementary Education 431; for the section in language arts, Elementary Education 336 or a course in the teaching of reading or language arts, or consent of instructor; for the section in creative arts, Elementary Education 337 or consent of instructor; for the section in science, Elementary Education 335 or a methods course in teaching science in the elementary school and two years of college science, or consent of instructor. ATKIN, CULLITON, LANSING, MCGILL, MOORE.

434. **Programs in Early Childhood Education.** An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. 1 unit. Prerequisite: Elementary Education 431. STENDLER.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. 1 unit. Prerequisite: Educational Psychology 312 or consent of instructor. R. A. SMITH, STENDLER, SUCHMAN.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the

major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. McGill, Shores.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the Dean. Staff.

455. **Theories of Art Education.** A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. 1 unit. Prerequisite: Elementary Education 337 or Secondary and Continuing Education 456, or consent of instructor. Lansing, Schultz.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of elementary education. 1 to 2 units. Staff.

490. **Seminar for Advanced Students of Education.** Seminar in elementary education open only to persons who have been admitted to candidacy for the Doctor of Philosophy or Doctor of Education and who have completed the preliminary examination. 1 to 2 units. Staff.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. Staff.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the classroom teacher and the specialist. Opportunity for experience in field and laboratory work. ½ unit. Prerequisite: Elementary Education 233 and 237, or equivalent; two years of college science. Atkin, R. W. Burnett.

336. **Primary Reading.** Critical evaluation of current schools of thought with regard to the teaching of reading and an analysis of the concept of learning as well as the meaning of reading upon which each school is based. Attention is given to reading as a part of the total growth process of the child and to knowledge of methods and materials used in teaching beginning reading. ½ unit. Prerequisite: Junior standing. Culliton, Moore, Powell, Shores.

337. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. ½ unit. Prerequisite: Junior standing. Breen, Lansing, Schultz.

History and Philosophy of Education

COURSES FOR GRADUATES

400. **Problems of Educational Theory.** Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305. McMURRAY.

401. **Modern Theories of Education.** A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. 1 unit. STANLEY.

402. **Educational Movements in the Twentieth Century.** A historical study of significant educational trends during the past sixty years, with special reference to their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. 1 unit. Prerequisite: History and Philosophy of Education 300, or 302, or 403, or consent of instructor. ANDERSON.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. 1 unit. Prerequisite: History and Philosophy of Education 300 or 302, or consent of instructor. ANDERSON.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. BROUDY.

405. **Foundations of Aesthetic Education.** A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas investigated. 1 unit. Prerequisite: Consent of instructor. BROUDY.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop an understanding of, and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. ANDERSON.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment, and knowing, examined from the standpoint of recent developments in pragmatism. 1 unit. Prerequisite: Consent of instructor. McMURRAY.

408. **Advanced Philosophy of Education.** A systematic exploration of knowledge and inquiry as they relate to problems of formulating educational policy, cur-

riculum design, organization of the school system, and teaching-learning. Selected materials in the history of epistemology are examined and emphasis is placed on a critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

409. **Advanced Philosophy of Education.** A study of the nature of value as it relates to problems of formulating and justifying educational aims and policies, curriculum design, organization of the school system, and teaching-learning. Selected materials in ethics, value theory, and aesthetics are used in the critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in education. BROUDY, SMITH, STANLEY.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in history and philosophy of education open only to persons who have been admitted to candidacy for the Doctor of Philosophy or Doctor of Education and who have completed the preliminary examination. Sections are usually offered in the following fields: (a) history of education, (b) philosophy of education, (c) comparative education, (d) social foundations of education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **The History of Education.** Brief introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. ½ unit. Prerequisite: Junior standing. ANDERSON.

301. **Philosophy of Education.** Based on Dewey's *Democracy and Education,* this course is an examination of experimentalist philosophy in its bearings on edu-

cational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. ½ unit. J. R. BURNETT, MCMURRAY, STANLEY.

302. **History of American Education.** The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. ½ unit. ANDERSON.

303. **Comparative Education.** A study of selected national systems of education in their differing cultural settings. ½ unit. KAULFERS.

304. **Social Foundations of Education.** An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. ½ unit. J. R. BURNETT, PALMER, SMITH, STANLEY.

305. **History of Educational Ideas.** Through a study of selected educational theorists and intellectual movements, this course provides familiarity with the major educational ideas of the past, as well as historical perspectives on current issues and problems in education. Readings in Plato, Quintilian, St. Augustine, Loyola, Comenius, Rousseau, Pestalozzi, Froebel, Herbart, Dewey, and others. ½ unit.

315. **Sociology of Education.** Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

Secondary and Continuing Education

COURSES FOR GRADUATES

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. I unit. STAFF.

441. **Linguistic and Logical Analysis of Teaching.** An analysis of teaching from the standpoint of semantic and logical factors. Topics such as theories of meaning, definition, explanation, and justification as employed by a teacher are discussed. 1 unit. K. B. HENDERSON, SMITH.

448. **Continuing Education.** Development, status, and prospects of continuing education for adults. Institutions, agencies, and programs; public policy and policy-making for continuing education; organization, administration, finance, and promotion; recruiting, training, and supervising staff; planning programs and courses; the literature of continuing education. Systematic study of individual problems supplements class work. ½ or 1 unit. PHIPPS.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

456. **Problems and Trends in Specialized Fields of Secondary Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. 1 unit. Sections are usually offered in the following fields: (a) English, (b) foreign languages, (c) mathematics, (d) science, (e) social science.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of secondary and continuing educaton. 1 to 2 units. STAFF.

467. **The American College.** Development of the American college and university; higher education processes, organization, and administration; the variety of problems and conflicting theories; policies, practices, and present trends. 1 unit.

490. **Seminar for Advanced Students of Education.** Seminar in secondary and continuing education open only to persons who have been admitted to candidacy for the Doctor of Philosophy or Doctor of Education and who have completed the preliminary examination. 1 to 2 units. METCALF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

360. **Educational Uses of Television and Radio.** Same as Communications and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation in new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

Special Education

COURSES FOR GRADUATES

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis, and social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, and anthropology, and psychology to educational theory and practice with reference to the mentally deficient. 1 unit. Prerequisite: Special Education 322 or consent of instructor. GALLAGHER, S. A. KIRK.

417. **Psycho-Educational Problems of Exceptional Children.** A course for educators, students in the behavioral sciences, and students beginning graduate study in special education. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children and consideration of major current problems in the development of educational programs.

1 unit. Prerequisite: Sixteen hours of psychology and/or education or consent of instructor. Bereiter, R. A. Henderson, Jordan.

418. **Communicative Problems of the Deaf.** An advanced course in the problems of the deaf in communication, including the learning of language, reading, speech, speech reading, and research in these areas. Consideration is given to the various methods that are used in the teaching of these basic skills to deaf children and to the social and psychological principles underlying the methods. 1 unit. Prerequisite: Consent of instructor. Quigley.

419. **Diagnosis of Learning Disabilities.** A clinical course in the diagnosis of learning disorders in children with particular emphasis on psycholinguistic and reading disabilities. The course includes study of the genetic, neurophysiological and psychological theories and constructs relating to learning disorders, and provides laboratory practice in the diagnosis of children with learning disorders. 1 unit. Prerequisite: Psychology 443 or Educational Psychology 343. S. A. Kirk.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, and of the somatopsychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. Implications for current educational programs for the handicapped are analyzed. 1 unit. Prerequisite: Special Education 117 or 417 and Educational Psychology 312, or consent of instructor. Farber, Newland.

421. **Administration and Supervision of Special Education.** Designed for advanced graduate students preparing for administrative or supervisory positions in special education programs. Administrative and supervisory practices in educating exceptional children are examined with emphasis on special education programs in the public schools; application of administrative theory to special education programs. Field trips to observe and evaluate programs are required. 1 unit. Prerequisite: Special Education 417 and Educational Administration and Supervision 460; consent of instructor. R. Henderson.

444. **Practicum in Remediation of Learning Disabilities.** A clinical course in the remediation of learning disabilities in children. The course includes a study of remedial philosophies, the relationships between diagnosis and remediation, specific remedial techniques, and their applicability to certain learning disorders, and provides supervised clinical practice in planning, executing, and reporting remedial programs. 1 unit. Prerequisite: Special Education 419. Kirk.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. Staff.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of special education. 1 to 2 units. Staff.

490. **Seminar for Advanced Students of Education.** Seminar in the education of exceptional children open only to persons who have been admitted to candidacy for the Doctor of Philosophy or Doctor of Education and who have completed the preliminary examination. 1 to 2 units. Staff.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised

design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. **The Gifted Child in School and Society.** A consideration of the gifted in society; who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. ½ to 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GALLAGHER, NEWLAND.

317. **Psycho-Social Educational Aspects of Deafness.** Historical and current societal perceptions of the deaf; and analysis of the various effects and patterns of auditory impairment on children and adults; intelligence, personal and social adjustment, the psychological processes, and how they affect the acquisition of language, speech, speech reading, reading, and writing. ½ to 1 unit. Prerequisite: Special Education 117 and Psychology 100 or Educational Psychology 211. QUIGLEY.

318. **Workshop and Laboratory in Education of Exceptional Children.** For those specializing in exceptional children. The following sections may be offered: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

319. **Special Education of the Deaf, I.** Survey of the curriculum and techniques in preschools, kindergarten, primary, and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child; study of sense training, lip reading, vocabulary development, reading techniques, elementary school subjects, language and speech development, auditory training, and curriculum construction. 1 to 1½ units. Prerequisite: Consent of instructor.

320. **Special Education of the Deaf, II.** Continuation of Special Education 319. 1 to 2 units. Prerequisite: Special Education 319.

321. **Education of Disturbed and Conduct-Problem Children.** A study of the social, emotional, and learning characteristics of children who are disturbed or who exhibit problems of conduct; methods of diagnosis and differentiation; educational environments and teaching methods used for their remediation. ½ to 1 unit. Prerequisite: Special Education 117 or equivalent, and Elementary Education 236 or equivalent.

322. **Psychology and Education of the Mentally Handicapped.** A study of the social, emotional, physical, and learning characteristics of mentally handicapped children; methods of diagnosis and differentiation; curriculum and teaching techniques employed for their education. ½ unit. Prerequisite: Elementary Education 231. JORDAN.

323. **Psychology and Education of the Mentally Handicapped.** Continuation of Special Education 322, with emphasis on curriculum. ½ unit. Prerequisite: Special Education 322. JORDAN.

324. **Mental and Educational Measurement of Exceptional Children.** Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech

defective. ½ or 1 unit. Prerequisite: Special Education 117 or consent of instructor.

Vocational and Technical Education

COURSES FOR GRADUATES

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. 1 unit.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not benig offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. 1 unit. MATHER, E. SIMPSON.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. 1 unit. E. SIMPSON.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. 1 unit. E. SIMPSON.

456. **Problems and Trends in Specialized Fields of Vocational and Technical Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. 1 unit Sections are usually offered in the following fields: (a) agricultural education, (b) business education, (c) home economics education, (d) industrial education.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of agriculture, business, home economics, and industry. ½ or 1 to 2 units. STAFF.

471. **Policy and Policy-Making for Education in Agriculture.** Local, state, and national policies for agricultural education; organizing for policy-making; developing desirable policies. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. Open to school administrators and extension educators without prerequisite. PHIPPS.

472. **Course Planning and Teaching Procedures in Vocational Agriculture.** Gathering data essential in course planning, constructing course plans, developing resource units, teaching procedures, and instructional aids. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277 or consent of instructor. HEMP, KREBS.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory

committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277 or consent of instructor. HEMP, KREBS.

474. **Supervised Agriculture Experience in Vocational Agriculture.** Supervised agricultural experience programs as an educational strategy, importance and meaning of supervised agriculture experiences; planning, conducting, supervising, and evaluating agriculture experience programs; relation of supervised agriculture experience programs to establishment and advancement in an occupation; keeping and using records; relating class instruction to supervised agriculture experience programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277 or consent of instructor. PHIPPS, WARMBROD.

475. **Organizing and Teaching Agriculture Mechanics.** Agriculture mechanics as a phase of vocational education in agriculture; purposes, course planning for high school students, young farmers, and adult farmers; methods of teaching and evaluating on-farm or on-job instruction; planning agriculture-mechanics shops and facilities; providing and teaching safety in agriculture mechanics. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277 or consent of instructor. PHIPPS.

476. **Guidance in Agricultural Education.** The guidance function in young farmers' and adult farmers' classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment, placement, follow-up. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277 or consent of instructor. KREBS.

481. **History and Basic Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. 1 unit. CAMPBELL.

482. **Research Studies in Vocational and Technical Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research project, or plans in detail a major research project to be completed later. 1 unit. R. EVANS, PHIPPS, E. SIMPSON.

487. **Seminar in Vocational, Technical, and Practical Arts Education.** Overview and interpretation of social, economic, and technological trends which have relevance to the problem of developing new programs in the vocational, technical, and practical arts areas; analysis and evaluation of innovations in the field; current issues and problems. 1 unit. Prerequisite: Graduate standing in vocational and technical education. KARNES, LUX, PHIPPS, SIMPSON.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses. Study of basic concepts underlying course construction in industrial education. 1 unit. Prerequisite: Undergraduate work in appropriate vocational and technical education courses. LUX.

489. **Administration and Supervision of Vocational and Technical Education.** Problems and approved practices in the administration and supervision of programs of vocational, technical, and practical arts education in secondary schools, junior colleges, and technical institutes. 1 unit. Prerequisite: Consent of instructor. KARNES.

490. **Seminar for Advanced Students of Education.** Seminar in vocational and technical education open only to persons who have been admitted to candidacy for the Doctor of Philosophy or Doctor of Education and who have completed

the preliminary examination. Sections of this seminar are usually offered in the following areas: (1) industrial education; (2) agricultural education; and (3) home economics education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructors to schools in which first-year teachers are employed. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. FULLER, WARMBROD.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. ½ or 1 units. TOMLINSON.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. ½ or 1 unit. LUX, STERN, TOMLINSON.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. I unit, Prerequisite: Sixteen hours in appropriate vocational and technical education courses. LUX, TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, and their relationships to other educational agencies. 1 unit. SCHILL.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Ten hours of undergraduate credit in appropriate vocational and technical education courses. LUX, STERN, TOMLINSON.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the Master of Science and Doctor of Philosophy is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. To be admitted, an applicant must have the equivalent of a grade-point average of 4.0 or B for the last sixty semester hours of undergraduate study. Courses for advanced undergraduates and graduates are also open for credit to qualified students majoring in other fields.

A minimum of eight units must be completed for the master's degree, including a thesis. At least four units must be at the 400 level, including a course in circuit theory and one in field theory. In addition, a physics course beyond the 100-level series is required.

All students desiring to enter the doctoral program must take the electrical engineering qualifying examination. Students who earn the master's degree at the University of Illinois take the examination during the last regular term of their master's program. Students who enter with the master's degree and wish to count it toward the doctoral program must take the examination during their first term here.

Eight units of course credit beyond the master's degree, or the equivalent, plus eight units of thesis research and a satisfactory thesis, are minimum requirements for the Doctor of Philosophy. In addition, the candidate must demonstrate reading proficiency in two of the following languages: French, German, Russian. He also must have completed two courses in physics beyond the usual sophomore sequence. In his course program he must offer a major and either one or two minors. A single minor requires four units in one field outside the major field, at least one of which must be at the 400 level. If two minors are chosen, each must consist of at least two units. Advanced courses in mathematics, physics, physiology, chemistry, nuclear engineering, and other branches of engineering are recommended minors.

Further details may be found in the *Electrical Engineering Graduate Study Manual,* available from the department.

GRADUATE FACULTY

Professors: E. C. Jordan (Head of Department) W. E. Miller (Associate Head of Department), F. Adler, G. E. Anner, L. B. Archer, W. R. Ashby, D. S. Babb, A. D. Bailey, J. Bardeen, S. A. Bowhill, R. M. Brown, P. D. Coleman, G. A. Deschamps, W. L. Emery, W. L. Everitt, G. H. Fett, W. J. Fry, L. Goldstein, P. Handler, H. N. Hayward, M. S. Helm, C. D. Hendricks, F. E. Hohn, N. Holonyak, P. E. Mayes, M. S. McVay, D. E. Muller, G. R. Peirce, D. Pines, W. J. Popplebaum, J. E. Robertson, C. T. Sah, P. F. Schwarzlose, S. Seshu, M. D. Sirkis, C. E. Skroder, G. W. Swenson, G. J. Thomas, M. E. Van Valkenburg, H. M. vonFoerster, N. Wax, H. D. Webb, J. E. Williams.

Associate Professors: W. G. Albright, R. B. Ash, D. L. Bitzer, R. W. Burtness, J. H. Cahn, D. A. Calahan, D. H. Cooper, M. H. Crothers, J. B. Cruz, Jr., F. Dunn, J. D. Dyson, P. R. Egbert, E. W. Ernst, F. J. Fry, D. F. Hang, E. C. Hayden, D. F. Holshouser, J. O. Kopplin, B. C. Kuo, G. H. Leichner, Y. T. Lo, P. E. Mast, W. Mayeda, R. Mittra, T. A. Murrell, J. P. Neal, K. C. Smith, K. C. Yeh.

Assistant Professors: M. L. Babcock, K. G. Balmain, H. C. Brearley, O. L. Gaddy, V. Gourishankar, E. C. Jones, P. W. Klock, W. W. Lichtenberger, G. A. Metze, W. R. Perkins, S. R. Ray, J. A. Resh, R. A. Rohrer, J. T. Verdeyen.

COURSES FOR GRADUATES

400. Seminar. Required of all graduate students. No credit.

412. **Advanced Engineering Measurements.** Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. 1 unit.

414. **Engineering Applications of Linear Graphs.** Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and

automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416, Mathematics 315 or 318.

415. **Control System Theory and Design.** Synthesis of feedback control systems to meet design specifications, including sensitivity; multivariable systems; introduction to systems with random inputs; state variable techniques; nonlinear systems. 1 unit. Prerequisite: Electrical Engineering 386 or equivalent, or consent of instructor.

416. **Analysis of Linear Networks and Systems.** Basic course in networks; frequency and time-domain analysis; foundations of loop and node equations; signal flow graph formulations: Fourier and Laplace transforms; two-port parameters; introduction to network function theory. 1 unit. Prerequisite: Credit or registration in Mathematics 346 or 348; Electrical Engineering 322 or equivalent.

418. **Electric and Magnetic Fields.** Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. 1 unit.

420. **Electromagnetic Waves and Radiating Systems.** Fundamental electromagnetic theory with applications to transmission lines, waveguides, and antennas; introduction to the solution of advanced problems in static electric and magnetic fields. 1 unit. Prerequisite: Electrical Engineering 352.

421. **Advanced Electromagnetic Engineering.** Reciprocity and equivalence principles; formulation of scattering and diffraction problems; approximations for large and for short wavelengths; plane, cylindrical, and spherical wave problems; variational methods; Wiener-Hopf techniques; applications to antennas and waveguide problems. 1 unit. Prerequisite: Electrical Engineering 420.

422. **Advanced Communication Networks.** Fourier integral and matrix algebra, analysis of networks, and network synthesis for wide band operation. 1 unit.

423. **Gaseous Electronics and Plasmas.** Irreversible thermodynamics; transport theory; magnetohydrodynamics; collective behavior. 1 unit. Prerequisite: Physics 362 and Electrical Engineering 420, or equivalent.

427. **Boundary Value Problems.** Derivation and solution of partial differential equations and integral equations of mechanics and electricity and magnetism; study of the analysis of wave motions. I unit.

428. **Analysis of Nonlinear Systems.** Same as Theoretical and Applied Mechanics 428. Singular points and stability considerations are treated. Graphical and analytical methods including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations are considered. 1 unit. Prerequisite: Mathematics 341 and consent of instructor.

429. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedback circuits and amplifiers, stability, equalizers, and relations between components of network functions. 1 unit.

431. **Theory of Guided Waves.** Propagation in general cylindrical waveguides; Eigenvalue problems; stationary principles; microwave circuit theorems, boundary value problems, and the determination of circuit parameters; periodically loaded waveguides with anisotropic media. 1 unit. Prerequisite: Electrical Engineering 420.

434. **Random Processes in Electrical Engineering.** Survey of measure theoretic probability theory; analysis of second order random processes, including the spectral theory and harmonic analysis; transmission of noise through linear and nonlinear systems; the signal detection problem. 1 unit. Prerequisite: Mathematics 361.

435. **Theory of Semiconductors and Semiconductor Devices.** Same as Physics 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of

Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

436. **Applied Electrodynamics.** Tensor form of Maxwell's equations, special relativity, radiation reaction, integration of wave equations. Fourier analysis of radiation fields. Lagrange and Hamiltonian equations. Applications to submillimeter wave generation. Cerenkov effect, radiation from particle accelerators, electron bunching at high energies. 1 unit. Prerequisite: Electrical Engineering 420 and 423.

437. **Principles of Microwave Measurements.** Generation and detection of the laboratory signal; the generalized impedance concept; matrix representation of waveguide discontinuities; determination of equivalent network parameters; analysis of measurement techniques by signal flow graphs; accuracy criteria. 1 unit. Prerequisites: Electrical Engineering 355 and 356.

440. **Advanced Power Circuit Analysis, I.** Analysis of power systems by symmetrical and related components; equivalent circuits of lines, transformers, and machines; fault calculations on symmetrical and unsymmetrical power systems; the network analyzer in fault studies. 1 unit.

442. **Advanced Analysis of Alternating Current Machinery.** Steady-state analysis of synchronous machines, round rotor and salient poles, magneto-motive forces with symmetrical and unsymmetrical windings, torque angle characteristics, vibration, and noise. 1 unit.

443. **Analysis of Dynamo Machines Under Transient Conditions.** Analysis of the operation of alternating and direct current machines under transient conditions, armature and field phenomena and mutual reactions of dynamo machines with system transients. 1 unit. Prerequisite: Electrical Engineering 442.

445. **Power System Stability.** Transient and steady-state stability in power systems; power flow equations; transient stability swing curves; critical clearing time; the network analyzer in stability studies; the analog computer in transient stability studies. 1 unit. Prerequisite: Electrical Engineering 440.

451. **Network Synthesis.** A study of methods for the synthesis of networks for prescribed driving-point and transfer characteristics. 1 unit. Prerequisite: Mathematics 345.

452. **Network Synthesis.** A continuation of Electrical Engineering 451. 1 unit. Prerequisite: Electrical Engineering 451.

453. **Optimum Control Systems.** Formulation of the optimization problem; controllability; observability; stability; Lyapunov's second method; application of variational calculus, maximum principle and principle of optimality to control problems; stochastic control; adaptive control. 1 unit. Prerequisite: Electrical Engineering 415.

454. **Sampled-Data Control Systems.** Analysis and design of feedback control systems with digital and sampled data. 1 unit. Prerequisite: Electrical Engineering 386 or 415, or equivalent.

463. **Information Theory.** Same as Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or Electrical Engineering 433.

467. **Atomic Collision Processes.** Same as Physics 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photoprocesses and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

472. **Quantum Electronics.** A brief theoretical introduction to quantum mechanics and atomic physics, with many applications in spin resonance and modern maser theory. 1 unit. Prerequisite: Physics 381. It is recommended that Physics 362 and 385 be taken before registering in this course.

473. **Fundamentals of Cybernetics.** Same as Biophysics and Communications 435. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 394 or Mathematics 361, or consent of instructor.

474. **Problems of Cybernetics.** Same as Biophysics and Communications 436. A continuation of Electrical Engineering 473. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Electrical Engineering 473.

475. **Ionospheric Radio Propagation.** Propagation in a stratified medium; WKB solution; ray theory; ionospheric sounding; ionospheric transmission problems; scattering by irregularities; propagation in a random medium; cross-modulation and nonlinear effects; magneto-ionic theory; Faraday effect; whistler propagation; coupling of characteristic waves; magneto-hydrodynamic waves; formation of ionospheric E-region; formation of F-region. 1 unit. Prerequisite: Electrical Engineering 420 or equivalent.

486. **Constitution of the Ionosphere: An Introduction to Aeronomy.** Same as Astronomy 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ions of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent.

497. **Electrical Engineering Problems.** Special electrical engineering problems. ½ to 2 units.

498. **Electrical Engineering Problems.** Special electrical engineering problems. ½ to 2 units.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

322. **Linear Network Theory, II.** Signal representation in terms of Fourier series, Fourier transforms, and Laplace transforms; role of exponential and sinusoidal signals in system analysis for arbitrary waveforms; two-ports and filters as signal processors. 0 to 1 unit. Prerequisite: Electrical Engineering 250 and 251; Mathematics 195 and 345.

323. **Circuit Laboratory.** To accompany Electrical Engineering 322 and 350. 0 or ¼ unit. Prerequisite: Electrical Engineering 251 and 322; credit or registration in Electrical Engineering 350.

324. **Introduction to Network Synthesis.** An introduction to modern methods of network synthesis; properties of driving-point and transfer functions; approximation and scaling; LC, RC, and RLC synthesis methods; ladder network development; and resistively terminated coupling networks. 0 to 1 unit. Prerequisite: Electrical Engineering 322.

330. **Magnetic Circuits and Transformers.** Magnetic circuit analysis; transformer theory; special magnetic circuit applications. 0 to ¾ unit. Prerequisite: Electrical Engineering 229, 250, and 251; credit or registration in Electrical Engineering 331.

331. **Magnetic Circuits and Transformers Laboratory.** To accompany Electrical Engineering 330. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330.

332. **Electrical Machinery.** Induction machines; single-phase motors; direct-current machines; application. 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 332. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

336. **Advanced Analysis of Electric Power Equipment.** Transformers, synchronous and induction machines; power machines in systems; single phase motors; extension of the two-reaction analysis to the general machine. 0 to ¾ unit. Prerequisite: Credit or registration in Electrical Engineering 332 and 333.

340. **Electronics.** Emission, electron ballistics, high vacuum electron tubes, semiconductors and transistors, tube and transistor characteristics and equivalent circuits, gaseous conduction and gas tubes, introduction to methods of analysis. 0 to ¾ unit. Prerequisite: Electrical Engineering 250 and 251.

341. **Electronics Laboratory.** To accompany Electrical Engineering 340. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 340.

342. **Advanced Electronics.** Linear and nonlinear amplification; modulation and demodulation concepts; introduction to feedback amplifiers and oscillators. 0 to ¾ unit. Prerequisite: Electrical Engineering 322, 340, and 341.

343. **Electronics Laboratory.** 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 342.

347. **Industrial Electronics.** Electronic circuits for automatic control and measurement systems with applications. 0 to 1 unit. Prerequisite: Electrical Engineering 322, 332, and 342. Credit toward graduation is not given for both Electrical Engineering 347 and 381.

349. **Electron Tube Circuits.** Linear and nonlinear amplifiers, fundamentals of modulation and detection, oscillators, rectifiers. 0 to 1 unit. Prerequisite: Electrical Engineering 342.

350. **Lines, Fields, and Waves.** Transmission lines, field calculations, and wave propagation. ¾ unit. Prerequisite: Electrical Engineering 229; Mathematics 195; credit or registration in Electrical Engineering 323.

352. **Electromagnetic Fields.** Uniform plane waves, wave guides, radiation and propagation of electromagnetic energy, radiating systems, and electrodynamics. ¾ unit. Prerequisite: Electrical Engineering 350 and 323; concurrent registration in Electrical Engineering 356 is recommended.

353. **Radio Circuits.** Component behavior at communication frequencies, impedance transforming networks for single and multiple frequencies; low-level tuned and compensated amplifiers, broad band impedance matching; equalizers. 0 to 1 unit. Prerequisite: Electrical Engineering 322 and 340.

355. **Fields and Waves.** Electromagnetic fields; wave guides; radiation and propagation of electromagnetic energy; radiating systems. 0 to ¾ unit. Prerequisite: Electrical Engineering 229 and 350, or consent of instructor.

356. **Microwave Techniques.** UHF and microwave sources and detectors; laboratory techniques for UHF and microwave frequencies. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 352 or 355.

357. **Radio Astronomy.** *Same* as Astronomy 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108.

359. **Introduction to Noise and Information Transmission.** Signals and their spectra; methods of communication systems analysis; modulation by AM, FM, PAM, PPM; origin of noise, properties of noise, introduction to probability theory, system comparison using statistical approach. ¾ or 1 unit. Prerequisite: Electrical Engineering 322; credit or registration in Electrical Engineering 342.

366. **Aeronomy: Physics of the Upper Atmosphere and Space.** Same as Astronomy 366 and Physics 366. Structure and composition of the earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

376. **Symmetrical Component Analysis of Power Systems.** Representation of power systems; symmetrical components, positive, negative and zero sequence impedances of network components, sequence networks; unsymmetrical faults, unsymmetrical power systems, matrix algebra in symmetrical component analysis. 0 to 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

378. **Electric Power Networks.** Steady-state power network analysis; inductive coordination; transmission line capacitance and resistance; networks synthesis; application of computers to power network problems. 0 to 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

381. **Pulse Techniques.** An introduction to the response of electrical networks to nonsinusoidal inputs, the analysis of active circuits with large signals, and the circuits and techniques used in pulse and digital equipment. 0 to 1 unit. Prerequisite: Electrical Engineering 322, 340 and 341, or consent of instructor.

382. **Transistor Circuits.** This course is the same as Electrical Engineering 383 but has one three-hour laboratory added each week. 1 unit. Prerequisite: Electrical Engineering 342, credit or registration in Metallurgical Engineering 384, or consent of instructor.

383. **Transistor Circuits.** Junction transistors, diodes, and related semiconductor devices. Emphasis equally divided between device properties as related to semiconductor physics and circuit properties. Small signal theory of amplifiers and oscillators, large signal theory of power stages and switching circuits, negative resistance effects, high frequency limitations. ¾ unit. Prerequisite: Electrical Engineering 342, credit or registration in Metallurgical Engineering 384, or consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. 0 to 1 unit. Prerequisite: Consent of instructor.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. 0 to 1 unit. Prerequisite: Electrical Engineering 340, 341, and Mathematics 345, or consent of instructor.

389. **Communication Design.** Over-all communication design problems; kinds of propagation; noise and interference; antenna temperature; transmitter power requirements; frequency selection; design of a portion of a receiver, transmitter, or antenna. 0 to ¾ unit. Prerequisite: Electrical Engineering 342 and 350.

391. **Boolean Algebras with Applications to Computer Circuits, I.** Same as Mathematics 391. An introduction to Boolean algebra with a discussion of the elementary applications to set theory, logic, and both relay and electronic switching circuits. The Harvard chart method and other methods for circuit simplification are treated both as applied to single output and multiple output circuits. ½ or 1 unit. Prerequisite: Senior standing; consent of instructor.

392. **Boolean Algebras with Applications to Computer Circuits, II.** Same as Mathematics 392. The notion of time as a parameter is introduced into the theoretical treatment of switching circuits. Examples of synthesis of time-dependent circuits are given using mathematical techniques. ½ or 1 unit. Prerequisite: Electrical Engineering 391.

393. Digital Computer Electronics. Transistor theory and pulse response of networks; reliable design of standard switching circuits; interrelation of components and systems; timing problems. ¾ or 1 unit. Prerequisite: Electrical Engineering 294, 340, and 341, or consent of instructor.

394. Logical Design of Automatic Digital Computer Circuits. Same as Mathematics 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Electrical Engineering 294 or consent of instructor.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric and Composition)

Students who wish to be considered for admission to graduate work in English must have attained a grade-point average of at least 4.0. However, students whose averages are between 3.75 and 4.0 are considered on an individual basis. All students must present the equivalent of at least twenty hours of undergraduate work in English or American literature, although students with at least fourteen hours may be considered on an individual basis and granted probational entrance. This does not include required college work in rhetoric.

Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates must take English 446 and are required to choose at least three of their courses from those at the 300 level and three from those at the 400 level. Candidates must complete two courses in each of three areas of study as recognized by the department and must demonstrate proficiency in one language chosen from French, German, or Russian.

Candidates must also pass a final examination. A master's thesis is not required, but each candidate must deposit one term paper with the department.

Master of Arts in the Teaching of English. Candidates must earn at least four units in English, at least two of them in courses at the 400 level, and they must take the final examination for master's candidates in English. They must also deposit one term paper with the department. Candidates must also have had the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, Russian, or Spanish.

Specific requirements are divided into two programs, the first for those who have the Bachelor of Arts in English and the teacher's certificate, and the second for those who have the Bachelor of Arts in English but not the teacher's certificate. These programs are designed to permit most candidates to complete the degree in two semesters and a summer. Those who lack certain prerequisites, such as general psychology, may need a little more time.

Electives may be in English, in education, or, in exceptional cases, in other subjects. At the time of his first registration, each candidate for this degree should apply for admission to advanced standing in teacher education, either with the adviser of the program, 109 English Building, or in 204 Gregory Hall.

Doctor of Philosophy in English. In addition to satisfying the general requirements of the Graduate College, candidates must take at least two units of work in problems courses—those courses numbered 450 and higher. The department recommends that all work be taken at the 400 level.

English 445 and 446. All entering graduate students are required to take English 445 and 446, Introduction to Advanced Graduate Study, during their first two semesters in residence, summer session not included.

Proficiency Examination. Graduate students entering the doctoral program after

taking degrees at other institutions are required to take a proficiency examination early in their first semester—or summer session—of residence.

Foreign Languages. Each student must demonstrate proficiency in two languages chosen from French, German, or Russian; but, with the approval of the adviser and the head of the department, he may petition the Dean of the Graduate College to be allowed to substitute Latin or Greek for one of these languages.

Minor Subjects. Students may offer a double minor, which includes English philology and one other subject, or a sole minor in English philology.

Preliminary Examination. This examination is given in October and February of each year. It consists of two parts, a written examination and an oral examination.

Thesis. The student must submit a statement of his thesis plan, outlining its main topics, to the adviser within a reasonable period—usually six months—after he passes his preliminary examination.

GRADUATE FACULTY

Professors: L. F. Dean (Head of Department), A. E. Barker, J. J. Campbell, E. H. Davidson, G. B. Evans, J. T. Flanagan, R. A. Gettmann, B. Harkness, M. T. Herrick, A. G. Holaday, J. N. Hook, B. A. Milligan, J. F. Nims, R. Ornstein, S. Paul, C. W. Roberts, C. H. Shattuck, D. A. Smalley, J. R. Squire, Jr., J. Stillinger, H. W. Wilson.

Associate Professors: A. L. Altenbernd, L. E. Berry, R. L. Haig, G. P. Haskell, J. F. Lynen, W. H. McBurney, S. Millet, F. B. Moake, H. F. Robins, A. L. Scott, G. Scouffas, G. B. Stillwell, Priscilla Tyler.

Assistant Professors: Kathryn Aston, E. J. Brandabur, S. Golding, F. E. Hodgins, U. M. Kaufman. R. L. Schneider, J. B. Trahern, R. H. Wasson, G. G. Wright.

English Literature and American Literature

COURSES FOR GRADUATES

401. **Old English: Anglo-Saxon.** An introduction to the language before 1000 A.D. 1 unit.

402. **Old English: Beowulf.** 1 unit. Prerequisite: English 401.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. 1 unit.

404. **Old English Literature and Its Cultural Background.** An intensive, critical examination of Old English prose and poetry exclusive of Beowulf. The texts studied vary from year to year, but particular attention is given to such important bodies of writing as the Elegies, the *Anglo-Saxon Chronicle,* and the works of Cynewulf, Aelfric, Alfred, and Wulfstan. 1 unit. Prerequisite: English 401 and 402.

405. **Middle English.** Introduction to Middle English dialects, with special emphasis on the East Midland. 1 unit. Offered in 1966-1967 and in alternate years.

406. **Middle English Literature and Its Cultural Background.** English literature from 1100 to 1500 (excluding Chaucer), with emphasis on chronicle, romance, debate, lyric, and such major poems as *Pearl, Sir Gawain and the Green Knight,* and *Piers Plowman;* historical, social, and religious backgrounds. 1 unit.

407. **Studies in Chaucer and His Times, I.** A study of Chaucer and his contem-

poraries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. 1 unit.

408. **Studies in Chaucer and His Times, II.** Continuation of English 407. 1 unit.

411. **Studies in Sixteenth-Century Literature, I.** 1 unit. MILLIGAN.

412. **Studies in Sixteenth-Century Literature, II.** Continuation of English 411. 1 unit. MILLIGAN.

413. **Studies in Shakespeare.** 1 unit. EVANS.

414. **Studies in Elizabethan Drama.** 1 unit.

416. **Studies in Late Renaissance Thought and Literary Theory.** The development of cultural ideas—religious, social, educational—in representative prose writers of the late sixteenth century and of the seventeenth century (Hooker, Bacon, Burton, Browne, Milton, Dryden, and others) in relation to literary theory and practice. 1 unit. BARKER.

417. **Studies in Seventeenth-Century Poetry and Milton (1600-1640).** I unit. BARKER.

418. **Studies in Seventeenth-Century Poetry and Milton (1640-1700).** Continuation of English 417. 1 unit. Prerequisite: English 417. BARKER.

421. **Studies in Eighteenth-Century Literature, I.** 1 unit.

422. **Studies in Enghteenth-Century Literature, II.** Continuation of English 421. 1 unit.

423. **Studies in the Eighteenth-Century Novel.** 1 unit. MCBURNEY.

427. **Studies in the Romantic Movement, I.** 1 unit. GETTMANN.

428. **Studies in the Romantic Movement, II.** Continuation of English 427. 1 unit. GETTMANN.

431. **Studies in Victorian Literature, I.** 1 unit. SMALLEY.

432. **Studies in Victorian Literature, II.** Continuation of English 431. 1 unit. SMALLEY.

433. **Major Movements in Modern British Poetry and Drama.** A study of important movements, figures, and ideas which shaped the criticism and practice of modern poetry. 1 unit.

434. **Major Movements in Modern British Fiction.** A study of important movements, figures, works, and ideas which shaped the criticism and practice of modern fiction. 1 unit.

437. **Studies in American Literature: 1600 to 1800.** Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor. DAVIDSON.

438. **Studies in American Literature After 1800.** A course which investigates literary movements, major writers, and intellectual and cultural ideas in American literature from 1800 to the present. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: Survey course in American literature or consent of instructor. DAVIDSON.

441. **Studies in Literary Theory.** The analysis, in accordance with aesthetic principles, of major documents in the history of poetics in order to formulate the central problems of literary theory and to examine proposed solutions to them. 1 unit.

442. **Studies in Recent Literary Theory.** The analysis of representative critics and critical schools of the twentieth century; similarities and differences between them and older critics in the solutions proposed to the central problems of literary theory. 1 unit.

445. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship. Required of all candidates for the degree of Doctor of Philosophy in English. 1/4 unit.

446. **Introduction to Advanced Graduate Study.** A consideration of the methods and objectives of literary criticism and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. 1/4 unit.

447. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. HOOK.

448. **Literary Analysis for Teachers of English.** An examination of the theoretical considerations underlying various approaches to teaching literature at the high school and introductory college level. 1 unit. Prerequisite: Teaching experience at secondary or college levels.

450. **Problems in Bibliographical Method.** Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor. EVANS.

457. **Problems in Medieval Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. 1 unit.

460. **Problems in English Renaissance Humanism.** Studies of specific problems, educational, religious, literary, in the thought and expression of sixteenth-century English humanism, with special reference to the thought and literary techniques of Thomas More, his reputation and his influence. 1 unit. Prerequisite: English 325 or 411 or consent of instructor. BARKER.

461. **Problems in Spenser.** A study of special problems relating to the works of Edmund Spenser, his background in England and in Ireland, and the second half of the sixteenth century. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: English 326 or any course on the sixteenth century.

462. **Problems in Tudor Drama.** 1 unit. HOLADAY.

463. **Problems in Shakespeare.** 1 unit. EVANS.

464. **Problems in Elizabethan Drama.** 1 unit. EVANS.

467. **Problems in Milton and His Age.** 1 unit. Prerequisite: English 342 or 418 or consent of instructor. BARKER.

471. **Problems in Eighteenth-Century Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 421, 422, or equivalent; or consent of instructor. HAIG.

476. **Problems in Romantic Literature.** A conference and research course concerning special problems, literary movements, and writers of the English Romantic period. The subject matter varies each time the course is offered. 1 unit. Prerequisite: English 427 and 428, or consent of instructor. STILLINGER.

478. **Problems in Prose Fiction.** 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Second-year graduate standing. GETTMANN.

479. **Problems in Victorian Literature.** Prerequisite: English 431 or 432 or consent of instructor. 1 unit. SMALLEY.

484. **Problems in Twentieth-Century English Literature.** A conference and research course devoted to selected writers and critical movements of the period. 1 unit. Prerequisite: English 433 or consent of instructor.

486. **Problems in American Criticism and American Culture.** Papers and discussions on literary critics and historians who have used literature as an index to the problems of American culture, 1900-1959. 1 unit. Prerequisite: English 376. PAUL.

488. **Problems in American Literature and Cultural History.** 1 unit. This course may be repeated for a total of two units. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN.

491. **Research in Special Topics.** Research in selected topics by arrangement with the instructor. This course may be repeated for a total of two units. 1 unit.

497. **Independent Reading.** A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrently with a 300-level course. No student may offer more than a total of ½ unit of English 497. Prerequisite: Consent of instructor of requisite 300-level course. ¼ unit.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. BARKER, BERRY, CAMPBELL, DAVIDSON, EVANS, FLANAGAN, GETTMANN, HAIG, HARKNESS, HERRICK, HOLADAY, HOOK, KASKE, KELLEY, LYNEN, MCBURNEY, MILLET, MILLIGAN, NIMS, ORNSTEIN, PAUL, ROBERTS, ROBINS, SCOTT, SHATTUCK, SMALLEY, STILLINGER, STILLWELL, TYLER, WILSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Same as General Engineering 304. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. DAVIS, MCCLINTOCK.

311. **Chaucer.** ¾ unit. STILLWELL.

316. **American Drama from 1900 to 1960.** A survey of American dramatic literature of the twentieth century, including the reading of a large number of plays which illustrate the diversity and importance of modern American drama. Special attention is given to the work of Maxwell Anderson and Eugene O'Neill. ¾ unit. FLANAGAN.

325. **English Literature from 1500 to 1660.** Survey of English literature of the Renaissance, exclusive of Milton and the drama. ¾ unit. MILLIGAN.

326. **Spenser and His Contemporaries.** A study of the principal preoccupations and forms of Elizabethan poetry, with special reference to Spenser. ¾ unit, Prerequisite: Six hours of English literature.

336. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. ¾ unit. HERRICK.

338. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. ¾ unit. ORNSTEIN.

339. **Comedy.** The history and theory of comic drama. ¾ unit. SHATTUCK.

340. **Satire.** Comparative study of the chief nondramatic satires of Western civilization, from Roman times to the present. Particular emphasis is given to the bearing these works and traditions have on English satire. ¾ unit. Offered in 1966-1967 and in alternate years.

342. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. ¾ unit. ROBINS.

345. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughn, Crashaw), with special emphasis on the poetry of John Donne. ¾ unit. EVANS, MILLIGAN.

346. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. ¾ unit. EVANS.

348. **Swift, Pope, and Fielding.** A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. Written reports and extensive readings. ¾ unit. Prerequisite: A course in English literature. HAIG.

349. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan; the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. ¾ unit. HAIG.

351. **The Mid-Victorian Novel.** Thackeray, Emily Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. ¾ unit. SCHNEIDER.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. ¾ unit. DAVIDSON, PAUL.

353. **Studies in Middle Western Literature, I.** A survey of Middle Western literature of the nineteenth century, with special emphasis on the development of realism in poetry and fiction. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

354. **Studies in Middle Western Literature, II.** A survey of Middle Western literature from 1900 to the present, with special emphasis on the development of realism in poetry and fiction. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

359. **The Origin and Development of the Folk Tale.** A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various countries (India, Greece, Norway, Ireland, Germany, Japan, and Africa) are analyzed, and North American Negro and Indian tales are discussed within this larger frame of reference. The semester's work concludes with an examination of folk motifs in the work of such American writers as Hawthorne, Poe, Melville, Twain, Faulkner, and others. ¾ unit. FLANAGAN.

360. **The Popular Ballad and the Folk Song in the United States.** A study of the British and Scottish popular ballad—the Child ballad as it is familiarly known —as it developed in Great Britain and as it was transplanted to the United States, with special emphasis on the development of native American ballads and songs. ¾ unit. FLANAGAN.

362. **The Art of the Lyric.** A study of lyric poetry as a genre. The examination of the nature of lyric convention and lyric originality through the reading of a body of related poems with special attention to the poetic manifestation of language and metaphor. ¾ unit.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as Speech 371. ½ or 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as Speech 372. ½ or 1 unit. HERRICK.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. ¾ unit. KELLEY.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democ-

racy, the content and range of American criticism. The analysis centers on the major American critics. ¾ unit. Prerequisite: English 113 and 114 or English 255 and 256. PAUL.

377. **Major American Poets.** A study of Poe, Whitman, Dickinson, Frost, Eliot, and Cummings with emphasis upon critical interpretation of their writings and the kinds of literary form characteristic of them. ¾ unit. Prerequisite: A course in English or American literature. LYNEN.

378. **Modern American and British Fiction in Its European Background.** A study of the interrelationship between certain themes and techniques in the development of the contemporary American, British, and European novel (from Dostoevsky, Melville, and Conrad through Mauriac, Dos Passos, Kafka, Gide, Faulkner, and Sartre to the present day). ¾ unit. Prerequisite: Two college-level literature courses.

380. **Mark Twain and the Rise of Realism.** A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. ¾ unit. Prerequisite: English 114 or 256, or consent of instructor. SCOTT.

381. **Themes and Movements in British Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. Prerequisite: Six hours of English or American literature.

382. **The Plays of Bernard Shaw.** ¾ unit. SHATTUCK.

384. **Comparative Studies in Twentieth-Century Poetry.** A study of contemporary poetry in English in its relationship to modern European verse. The poets studied may vary each time the course is offered. ¾ unit. Prerequisite: Three hours in either poetry or modern literature, or consent of instructor.

385. **Themes and Movements in American Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. ALTENBERND, HODGINS.

387. **The Structure of English.** Same as Linguistics 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit.

Rhetoric and Composition

COURSES FOR GRADUATES

400. **Verbal Communication in English as a Second Language for Graduate Foreign Students, I.** A language laboratory course concentrating on the typical writing problems that a graduate or research student encounters in an American university. No graduate credit. Prerequisite: Rhetoric 111 or consent of instructor.

401. **Verbal Communication in English as a Second Language for Graduate Foreign Students, II.** A language laboratory course dealing with individual, immediate, and specialized speaking and writing problems, with particular attention to orienting the graduate student to the techniques of the American university in thesis and other specialized writings and in the oral presentation of such material. No graduate credit. Prerequisite: Rhetoric 400 or consent of instructor.

480. **The Theory and Practice of English Composition.** An examination of modern prose style and consideration of problems confronting writers and teachers of writing at the college and high school levels. ½ unit. HOOK, MOAKE, WILSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

330. **The Writing of Poetry.** The practice of the writing of poetry, aided by intensive study of examples. ¾ unit. Prerequisite: Six hours of English or American literature, or consent of instructor. NIMS.

388. **Linguistics in Language Learning.** Same as Linguistics 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language; consent of instructor.

ENTOMOLOGY

See descriptions and course listings under Life Sciences, page 222.

EXTENSION EDUCATION

This program leads to the professional degree of Master of Extension Education and is open to persons holding a bachelor's degree in agriculture, home economics, or a closely related area. Admission to the program requires a grade-point average of at least 3.5 for the last sixty semester hours of undergraduate work.

Candidates are required to complete a minimum of eight units, and nine units are required if a thesis is not submitted. Three of these units must be in 400-level courses with one unit in the major field. A major (four units) may be taken in agriculture, home economics, or the social sciences. Students majoring in agriculture or home economics select four additional units from the social sciences; those majoring in the social sciences select four additional units from agriculture or home economics. All courses selected must be approved by the student's adviser. If a thesis is not submitted, the ninth unit may be selected in any area approved by the adviser. Students majoring in home economics must take work in three of the four major divisions of the department, unless proficiency in one or more of the areas is demonstrated by examination. At least four units must be earned in residence on the Urbana campus. Total extramural credit cannot exceed three units.

Inquiries concerning the Master of Extension Education should be directed to Professor Ernest W. Anderson, 116 Mumford Hall.

FINANCE

The Department of Finance offers graduate work leading to the Master of Science and Doctor of Philosophy in Finance. The following fields are available for specialization within the department: money, credit, and banking; corporation finance; corporation history; investment; insurance; urban land utilization.

The grade-point average required for admission to graduate study in the department is 3.75, although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis. A candidate for a degree in finance must also meet the general admission requirements of the Graduate College. He must also have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

A candidate for the Doctor of Philosophy must pass a preliminary examination. Graduate study in accountancy or statistics, or both, is advised strongly for doctoral candidates majoring in finance.

The Doctor of Philosophy program for the first year must include (1) two units of economic theory, (2) four units of finance, and (3) two additional units in finance or related fields. Two of the finance units should be in thesis research. The second year of study includes eight units which provide (1) a concentration in finance, (2) understanding of one or more fields in economics in addition to economic theory, and (3) proficiency in any other related minor field offered.

GRADUATE FACULTY

Professors: P. M. Van Arsdell (Head of Department), C. T. Arlt, R. W. Mayer, R. I. Mehr, R. C. Osborn.

Associate Professors: T. E. Cammack, R. A. Hedges, A. J. Heins, J. W. Leonard.

Assistant Professor: J. R. Pike.

COURSES FOR GRADUATES

420. **Central Banking Policy.** An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. 1 unit. Arlt.

425. **The Money Market and Financial Stabilization.** A study of interest rate determination; the structure and operations of the money and capital markets; the objectives and implementation of monetary, fiscal, and debt management policies. 1 unit. Prerequisite: Finance 250. Arlt.

427. **Commercial Bank Management.** A study of the principal policies and problems which confront top management. Major emphasis is given to liquidity, loans, investments, deposits, and capital funds, but consideration is also given to bank statements, organization structure, operations, personnel, cost analysis, and public relations. Instructional methods utilize readings, cases, and research projects. 1 unit. Prerequisite: Finance 250. Heins.

454. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. 1 unit. Prerequisite: Finance 254. Van Arsdell.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. 1 unit. Prerequisite: Finance 254. Van Arsdell.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investment, on a critique of investment policy, and on the valuation of investment media. 1 unit. Mayer.

460. **Theory of Insurance.** A study of the nature and cost of risk in our economic society and of the methods of handling it. 1 unit. MEHR.

490. **Individual Study and Research.** Directed reading and research. ½ to 1 unit. STAFF.

499. **Thesis Research.** Required for those writing master's and doctor's theses in finance. 0 to 4 units. MAYER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **Consumer Finance.** Nature and importance of consumer finance; trends in consumer credit; instruments and institutions of consumer credit; economic effects of consumer finance; consumer credit and public policy. ½ to 1 unit. Extra work is required of graduate students who register for 1 unit. Prerequisite: Economics 102 or 108; Finance 250 and 254, or consent of instructor.

357. **Financing Small Business.** Size and nature of small business; significance and limitations of small business; financial structure and problems; financial assistance to small business; future prospects of small business. ½ to 1 unit. Prerequisite: Finance 254 or 257. OSBORN.

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities, of senior securities with speculative features, of common stocks, of government and municipal securities, and of investment company securities. ½ to 1 unit. Prerequisite: Accountancy 108 and Finance 254. MAYER.

360. **Group Insurance and Pensions.** Same as Labor and Industrial Relations 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 248 (formerly Management 248). MEHR.

363. **Estate Planning.** A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. ½ to 1 unit. Prerequisite: Finance 262. MEHR.

368. **Survey of Urban Real Estate.** A board survey of the field of real estate and urban land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor.

369. **Urban Land Problems.** A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for individual study. Whenever possible the problems are selected and developed jointly with the Departments of Urban Planning and Landscape Architecture, Architecture, and others. ½ to 1 unit. Prerequisite: Finance 368 or consent of instructor.

370. **Risks and Risk Management.** Analysis of the financial problems in the risks of property damage or bodily injury in business situations and evaluation of the alternative methods for dealing with such problems. ½ to 1 unit. Prerequisite: One of the following: Accountancy 105 or 201; Economics 102 and 103, or 108; Finance 254 or 257. HEDGES.

FOOD SCIENCE

(Including Dairy Technology)

The Department of Food Science offers graduate work leading to the Master of Science and Doctor of Philosophy in either Food Science or Dairy Technology.

The grade-point average required for admission to graduate study is 3.75, although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis.

To obtain a graduate degree in food science, a student must have credit (graduate or undergraduate) in Chemistry 350 and 355, Microbiology 311 and 312, Food Science 301, 302, 421 (M.S., one-fourth unit; Ph.D., one-half unit), and 499 (M.S., two units; Ph.D., eight units).

Doctor of Philosophy. Candidates for the Doctor of Philosophy should complete formal course work and satisfy the language requirements (German, and French or Spanish) by the end of the second year of residence so that a minimum of one year may be spent in research. Each candidate must take a comprehensive written examination before the oral preliminary examination for the doctorate.

Graduate credit courses offered outside the Department of Food Science may be applied in partial satisfaction of the major unit requirements. These may be selected from closely related fields of study, such as microbiology, chemistry, physics, engineering, and applied biological sciences, and are subject to the approval of the major department. Minors may be selected from these same fields as well as from economics and management.

Second-year and third-year graduate students are expected to attend all seminars (Dairy Technology 404) in dairy technology, but they can register for a maximum of only one unit of credit. Dairy Technology 403 (one unit), Agronomy 440, and Dairy Technology 499 (eight units) are also required for the Doctor of Philosophy.

A student planning to take a major or minor in food science should have a Bachelor of Science in a recognized field of biological, physical, agricultural, or engineering science in which a minimum of the undergraduate credits are as follows: biology, six hours; physics, eight hours; calculus, five hours; microbiology, five hours; analytical chemistry, five hours; organic chemistry, five hours; physical chemistry, four hours; and food science or equivalent, twenty hours.

Master of Science. To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350 and 355, Dairy Technology 401 (one unit), 404 (one unit), and 499 (two units). A course in statistics is also necessary unless such a course was taken by the student when an undergraduate. The remainder of the eight units required for the Master of Science can be taken in the major and minor fields.

Research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing.

Candidates for the master's degree must complete one language requirement (German, French, or Spanish) and one minor and are required to take an examination covering the field of general food science and of their specialization. The candidate must present a thesis unless this requirement is waived by petition to the department.

GRADUATE FACULTY

Professors: R. T. Milner (Head of Department), E. O. Herreid, L. B. Howard, F. A. Kummerow, A. I. Nelson, Z. J. Ordal, M. P. Steinberg, J. Tobias, S. L. Tuckey, R. M. Whitney.

Associate Professors: T. Nishida, L. D. Witter.

Assistant Professors: C. Argoudelis, K. A. Narayan, E. G. Perkins, D. Sgoutas, L. Wei, H. K. Wilson.

Food Science

COURSES FOR GRADUATES

404. **Special Topics in Food Science, III: Technology of Fats and Oils.** A study of the commercial technology of fats and oils, including soaps and protective coating. Offered in 1966-1967 and in alternate years. 1/4 unit. Prerequisite: Food Science 391 or consent of instructor. NARAYAN.

406. **Special Topics in Food Science, IV: State and Metabolism of Lipids.** An advanced study of the state of lipids in animal tissues and in biological fluids, and of the metabolism of lipids in relation to dietary fats and other food constituents. Offered in 1966-1967 and in alternate years. 1 unit. Prerequisite: Chemistry 350, or consent of instructor. NISHIDA.

421. **Seminar.** Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food science. 1/4 unit. STAFF.

430. **Carbohydrates in Foods.** Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. 3/4 unit. Prerequisite: Chemistry 355, 354, or 350, or consent of instructor.

481. **Advanced Studies in Food Science.** Library or laboratory assignments on specific problems of limited scope involving individual commodities or processes. 1/2 to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, dehydrating, and fermenting methods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Food Science 201 or equivalent. NELSON, WEI.

302. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; vacuum and freeze drying of foods; evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Food Science 202 and 301, or equivalent. NELSON, WEI.

332. **Principles of Sanitation in the Processing and Handling of Foods.** A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and micro-organisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulations. Local field trips to food processing plants. 1/2 unit. Prerequisite: Microbiology 100 and 101 and Chemistry 132, or equivalent. ORDAL, WITTER.

363. **Introduction to Process Engineering.** Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. 3/4 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Chemistry 340 or 342; one year of calculus; or consent of instructor.

373. **Advanced Food Microbiology.** A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the

biological or enzymatic activities of bacteria, yeasts, or the higher fungi. 1¼ units. Offered in 1965-1966 and in alternate years. Prerequisite: Chemistry 133: Microbiology 311 and 312. ORDAL, WITTER.

391. **Special Topics in Food Science, I: Chemistry of Lipids in Foods.** A detailed survey of the chemical and physical properties of lipids. Offered in 1966-1967 and in alternate years. ½ unit. Prerequisite: Credit or registration in Chemistry 350 or consent of instructor. PERKINS.

393. **Special Topics in Food Science, II: Experiments in Lipid Chemistry.** Laboratory exercises, demonstrations, and assigned readings. Offered in 1966-1967 and in alternate years. ½ unit. Prerequisite: Registration in Food Science 391 or consent of instructor. ARGOUDELIS.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy Technology.** Study of fundamentals and fundamental problems involved in the processing of milk and milk products. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Chemistry 350. HERREID.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Consent of instructor. WHITNEY.

404. **Seminar.** Review of current literature in dairy technology. Students may register for credit only twice for a maximum of one-half unit. ¼ unit. STAFF.

491. **Assigned Problems in Dairy Technology.** Research on special problems for graduate students with a major interest in dairy technology. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Dairy Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. ½ unit. Prerequisite: Consent of instructor. WILSON.

310. **Dairy Product Processing.** Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, dried milk, and ice cream. 1 unit. Prerequisite: Food Science 201 and Dairy Technology 211; credit or registration in Dairy Technology 213. HERREID.

311. **Dairy Product Processing.** Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, casein, lactic acid, lactose, and fermentation products of whey. 1 unit. Prerequisite: Dairy Technology 211 and 213. TUCKEY.

312. **The Chemistry of Milk and Milk Products.** Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. Offered in 1966-1967 and in alternate years. ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 213 or Chemistry 122. WHITNEY.

FORESTRY

The Department of Forestry offers graduate work leading to the degree of Master of Science in Forestry to graduates of forestry curricula substantially equiv-

alent, in scope and standards, to those of the University of Illinois. The minimum grade-point average for admission to graduate study is 3.5. The program is intended for the forestry graduate who desires to deepen his understanding of the scientific principles which underlie some particular phase of forestry, such as forest ecology, economics, genetics, management, mensuration, protection, or soils; or aerial photointerpretation and wood technology.

In consultation with his adviser, a student plans a program which meets the general requirements of the Graduate College and serves his particular needs and interests. Such a program must include a seminar in forestry and, in most instances, original research and the presentation of a thesis on an appropriate problem. The thesis requirement may be waived only if, in the judgment of the departmental graduate committee, such waiver will result in a better program in a specific case. Advanced courses related to the student's special interest are found in such areas as biometrics, botany, climatology, economics, entomology, genetics, mathematics, photogrammetry, plant pathology, and soil science (see departmental listings).

A candidate must earn eight units of graduate credit, with at least three units in courses at the 400 level. He must also pass an oral examination covering the general field of forestry and the area of his specialization.

GRADUATE FACULTY

Professors: J. N. Spaeth (Head of Department), W. R. Boggess, I. I. Holland, C. S. Walters.

COURSES FOR GRADUATES

400. **Seminar.** Discussions on specialized topics and current literature in forestry. Required of all graduate students in forestry. ¼ unit. May be taken twice for a total credit of one-half unit.

401. **Special Problems.** Individual studies or investigations in selected branches of forestry. ½ to 1 unit. Not more than one unit may be offered for an M.S. degree.

499. **Thesis Research.** Research may be conducted in various phases of forestry. Subject must be approved by departmental committee. 1 to 3 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Forest Soils.** Soil factors related to forest hydrology and tree growth. Students take a two-week field trip, with students from Forestry 213, to southeastern states; estimated expense, $65.00. Graduate students are required to attend a special seminar. ½ unit. Prerequisite: Agronomy 101 and Forestry 212; or graduate standing in Botany with Botany 381 or equivalent.

362. **Forest Entomology.** A study of the characteristics, life histories, and forest relationships and controls of the economically important forest insects of the United States. ½ unit. Prerequisite: One year of biological science and one year of chemistry.

FRENCH

The Department of French offers graduate work leading to the Master of Arts, Master of Arts in the Teaching of French, and Doctor of Philosophy.

Students are admitted with a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Students electing French as a major subject should have had a college major in French, including practical work in the use of the language and advanced work in literature. Some knowledge of other Romance languages and literatures is desirable. A basic knowledge of Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates must pass an examination based on a general reading list. Candidates preparing to teach French must take French 311, 313, and 314 unless they can demonstrate proficiency.

Doctor of Philosophy in French. Candidates are expected to take at least two units in seminar courses (French 457-458, 459, 460). Candidates also are required to include French 475 and 476, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject. French 406 also is required.

Master of Arts in the Teaching of French. Candidates for the Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 311, 313, 314, two units; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. Candidates must pass an examination based on a general list.

GRADUATE FACULTY

Professors: C. A. Knudson (Head of Department), S. D. Braun (Visiting), P. Kolb, B. H. Mainous, C. P. Viens.

Associate Professor: F. W. Nachtmann.

Assistant Professors: Barbara C. Bowen, V. E. Bowen, S. E. Gray, E. Jahiel, F. M. Jenkins, J. K. Simon.

COURSES FOR GRADUATES

400. Beginning French for Graduate Students. Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit.

401. Reading French for Graduate Students. Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

405. Teaching College French. A study of the problems of teaching French at the college level, including classroom procedures and language laboratory techniques. No credit. Mainous.

406. Research Methods. Orientation in graduate research, introduction to bibliographical problems, and survey of methodology for papers and dissertations. ¼ or ½ unit. V. Bowen.

Note: In any given year a selection from the following courses will be offered. For current information, consult the department office or the current semester Time Table.

424. Studies in French Poetry. Versification, poetic structure, problems of imagery and meaning, and practical work in the interpretation of individual poems. 1 unit. Gray.

425. **Explication de textes, I.** Exercises according to the method of *explication de textes,* applied to texts selected principally from the period 1944-1958. 1 unit. Offered in 1965-1966 and in alternate years.

426. **Explication de textes, II.** The French method of *explication de textes* applied to selected texts of the principal French writers, in particular the *penseurs et essayistes.* 1 unit. Offered in 1966-1967 and in alternate years.

431. **History of Old French Literature, I.** Lectures on the history of French literature from the eleventh through the fifteenth century, with illustrative reading in translation. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Graduate standing in French or related department. KNUDSON.

432. **History of Old French Literature, II.** 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Graduate standing in French or related department. KNUDSON.

433. **Villon, Rabelais.** 1 unit. Offered in 1965-1966 and in alternate years.

434. **Montaigne, La Pleiade.** 1 unit. Offered in 1966-1967 and in alternate years.

435. **Seventeenth-Century Literature, I.** 1 unit. Offered in 1965-1966 and in alternate years.

436. **Seventeenth-Century Literature, II.** 1 unit. Offered in 1965-1966 and in alternate years.

437. **Eighteenth-Century Literature, I.** 1 unit. Offered in 1966-1967 and in alternate years.

438. **Eighteenth-Century Literature, II.** 1 unit. Offered in 1966-1967 and in alternate years.

447. **Nineteenth-Century Literature to 1850, I.** 1 unit. Offered in 1966-1967 and in alternate years.

448. **Nineteenth-Century Literature to 1850, II.** 1 unit. Offered in 1966-1967 and in alternate years.

453. **French Realism and Naturalism, I.** 1 unit. Offered in 1965-1966 and in alternate years.

454. **French Realism and Naturalism, II.** 1 unit. Offered in 1965-1966 and in alternate years.

457. **Seminar in Proust, I.** ½ unit. Offered in 1966-1967 and in alternate years. KOLB.

458. **Seminar in Proust, II.** ½ unit. Offered in 1966-1967 and in alternate years. KOLB.

459. **Seminar in Modern French Literature, 1870 to 1935.** An intensive study of one or two authors of the late nineteenth and early twentieth centuries. Authors who may be studied include the Parnassian or Symbolist poets and the following novelists: Barrès, Bourget, Anatole France, Loti, Gide, Martin du Gard, Duhamel, Mauriac, Giraudoux. 1 unit. Offered in 1966-1967 and in alternate years. Students may receive credit more than once. KOLB.

460. **Seminar in French Literature.** Discussion and research on some specialized area in French literature. Topic will be announced in advance. Course may be repeated for credit. 1 unit.

465. **La Littérature Contemporaine, I.** In French. Twentieth-century poets and novelists. 1 unit. Offered in 1966-1967 and in alternate years.

466. **La Littérature Contemporaine, II.** 1 unit. Offered in 1966-1967 and in alternate years.

475. **Old French Philology, I.** Reading of characteristic masterpieces of medieval French literature and study of the development of the Old French language from Latin. 1 or 1¼ units. Offered in 1966-1967 and in alternate years. Prerequisite: Consent of instructor; elementary knowledge of Latin; reading knowledge of German. KNUDSON.

476. **Old French Philology, II.** 1 or 1¼ units. Offered in 1966-1967 and in alternate years. Prerequisite: French 475. KNUDSON.

491. **Individual Topics.** ¼ to 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The prerequisite for all courses in this group is French 201 and 202, or equivalent.

309. **Survey of French Literature, I.** ¾ or 1 unit.

310. **Survey of French Literature, II.** ¾ or 1 unit.

311. **Diction Française.** Training in the improvement of French pronounciation, with special attention to the problems of teachers. It is recommended that this course and French 313 be taken concurrently. ½ unit. Prerequisite: Consent of instructor.

313. **Phonétique de la Langue Française.** A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 311 be taken simultaneously. ¾ unit. Prerequisite: Consent of instructor.

314. **Syntaxe Française Avancée.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. ¾ unit. Prerequisite: Consent of instructor.

316. **Structure de la Langue Française.** A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313, or equivalent training in phonetics.

317. **Le Théâtre Français Depuis 1800, I.** ¾ unit. Offered in 1966-1967 and in alternate years. JAHIEL.

318. **Le Théâtre Français Depuis 1800, I.** ¾ unit. Offered in 1966-1967 and in alternate years. JAHIEL.

323. **Littérature du Dix-Septième Siècle, I.** Major writers of the pre-classical period. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: French 201 and 202, or equivalent. DELEY.

324. **Littérature du Dix-Septième Siècle, II.** Major writers of the classical period. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: French 201 and 202, or equivalent. DELEY.

327. **La Littérature Française du Dix-Huitième Siècle, I.** Montesquieu, Voltaire, and their contemporaries. ¾ unit. Prerequisite: French 201 and 202, or equivalent. V. BOWEN.

328. **La Littérature Française du Dix-Huitième Siècle, II.** Diderot, Rousseau, and their contemporaries. ¾ unit. Prerequisite: French 201 and 202, or equivalent. V. BOWEN.

331. **Le Roman Français du Dix-Neuvième Siècle, I.** From Balzac to Proust. ¾ unit. Offered in 1965-1966 and in alternate years.

332. **Le Roman Français du Dix-Neuvième Siècle, II.** From Balzac to Proust. ¾ unit. Offered in 1965-1966 and in alternate years.

333. **La Littérature Contemporaine, I.** In French. Modern poetry from Baudelaire to Valéry. Prose writers from 1900 to 1940. Offered in 1965-1966 and in alternate years. ¾ unit.

334. **La Littérature Contemporaine, II.** Offered in 1965-1966 and in alternate years. ¾ unit.

335. **Civilisation Française, I.** In French. A survey of French life and French institutions, intended as a background for literary studies and as a preparation for the teaching of French. ¾ unit. MAINOUS.

336. **Civilisation Française, II.** ¾ unit. MAINOUS.

382. **Language Laboratory Techniques.** Same as German, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

GENERAL ENGINEERING

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE FACULTY

Professors: J. S. DOBROVOLNY (Head of Department), S. G. HALL, B. O. LARSON, E. C. MCCLINTOCK, J. E. PEARSON.

Associate Professor: F. L. SPALDING.

Assistant Professor: R. J. PLACEK.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Same as English 304. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. MCCLINTOCK.

313. **Advanced Methods in Engineering Graphical Computations.** Application of determinants in the theory and construction of engineering nomograms; curve fitting and formulation of empirical formulae; methods and application of graphical calculus. ½ or 1 unit. Prerequisite: Mathematics 142 or equivalent. PLACEK.

330. **Industrial Standardization.** Evolution and history of standardization; local, national, and international standardization; governmental standardization. Special emphasis is placed on standardization procedures for individual industrial establishments. ½ unit. Prerequisite: Consent of instructor. SPALDING.

360. **Engineering Applications of Meterological Fundamentals.** The application of the fundamentals of meteorology to engineering problems including the transport and diffusion of particulate matter, aerosols, and gases; precipitation processes and rainout; behavior of stack effluents, explosion debris, and radioactive materials in the atmosphere. Applications to operation scheduling and to site selection. 1 unit. Prerequisite: Mathematics 142 or 143; Physics 106, 107, and 108; Mechanical Engineering 205 and 206, or 209, or Chemistry 342 and 344, or Physics 360. PEARSON.

393. **Special Problems.** Study of advanced problems related to general engineering and graphics. ½ or 1 unit. Prerequisite: Consent of instructor. LARSON, STAFF.

GENETICS

A Ph.D. program in genetics is provided through the cooperative efforts of eight different departments of biology and is administered by the University

Committee on Genetics. Training in biochemical genetics, cytogenetics, and population genetics of a variety of organisms is provided. Students seeking master's degrees are directed to the various departmental programs, or to the master's program in biology offered by the School of Life Sciences.

Applicants for admission should have at least a 4.0 grade-point average for the last sixty hours, but may be considered for admission with a 3.75 average. They should also have completed one year of college physics, quantitative and organic chemistry, trigonometry, and analytic geometry. Calculus is strongly recommended. During the first calendar year of graduate study, students are required to take an advisory examination in the major genetic areas.

During the first two years, candidates should complete courses or demonstrate proficiency in biological chemistry (Chemistry 350, 355), calculus (Mathematics 132, 142, or 133, 143), statistics (Mathematics 363 or Agronomy 440), cytology (Botany 420), cytogenetics (Botany 421), population genetics (Animal Science or Dairy Science 411, or Zoology 407), and microbial genetics (Microbiology 330). All programs of study must be approved by the Genetics Committee. Students wishing a sole minor in genetics are required to complete four units of work in areas approved by the Committee and including at least ¾ unit in a 400-level course outside the major area.

Students majoring in genetics ordinarily elect minors in one of the biology departments and in either chemistry or mathematics. Students in the genetics program are eligible for fellowships and assistantships in the participating departments and should indicate their departmental preference (Agronomy, Animal Science, Botany, Dairy Science, Horticulture, Microbiology, Psychology, or Zoology) when applying for admission.

Thesis research may be carried out under the direction of appropriate staff members in the participating departments under departmental course listings. Inquiries concerning the program should be directed to the Chairman of the Genetics Committee, Professor David L. Nanney, 220 Burrill Hall.

GEOGRAPHY

The Department of Geography offers work leading to the Master of Arts, Master of Science, and Doctor of Philosophy. The systematic specializations of the department are: theoretical and applied area development, regional geography, and physical-ecological geography.

Students applying for admission must have a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All candidates for advanced degrees in geography must have an average of at least 4.25 in previous work in geography.

Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose backgrounds are largely in physical geography are recommended for the Master of Science; others receive the Master of Arts.

At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the departmental graduate committee. Students must have had, either as undergraduates or as graduates, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of a University of Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political science, sociology, or anthropology are recommended in the social sciences.

Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are geography electives, two

units in education, and two units in electives. Requirements are Geography 495, two units; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. Two electives must be in geography and the other two in geography, education, or, in exceptional cases, other fields. The grade-point average required for admission is 3.5. The adviser for candidates for this degree is Professor J. H. Garland, 224 Davenport Hall.

Doctor of Philosophy. The doctoral student is expected to penetrate deeply into specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for this degree must have taken, either as undergraduates or as graduates, all work required in the undergraduate major and the master's and doctor's programs of the department or the equivalent.

Admission to candidacy for the Doctor of Philosophy in geography is recommended after the successful completion of:

(1) At least sixteen units of graduate credit, or equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography. The department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology; the other in anthropology, economics, history, political science, sociology, Latin American studies, or Russian studies. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination.

After being admitted to candidacy for the Doctor of Philosophy, the student must complete a research thesis, eight units of Geography 499, which normally requires field investigation.

GRADUATE FACULTY

Professors: J. A. Russell (Head of Department), A. W. Booth, J. D. Fellmann, F. W. Foster, J. H. Garland, H. G. Roepke, D. B. Shimkin.

Associate Professors: C. Alexander, E. W. Cavins, C. H. Nichols, J. Thompson.

Assistant Professors: R. W. Armstrong, E. G. Smith, Jr.

COURSES FOR GRADUATES

412. **Analytical Climatology.** A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Armstrong.

421. **Regional Concepts in Geography.** Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. ½ unit. Prerequisite: Nine hours of regional geography. Garland.

429. **The Evolution of Agricultural Economies.** Same as Agronomy and Anthropology 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. Alexander, Staff.

461. **Fundamentals of Bioclimatology.** Same as Physiology 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the

application of meteorlogical, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor. ARMSTRONG, SARGENT.

462. **Experimental Bioclimatology.** Same as Physiology 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Perequisite: Physiology 301, or 401 and 402; credit or registration in Geography 461. ARMSTRONG, SARGENT.

463. **Historical Geography.** Objectives and methods of historical geography. 1 unit. RUSSELL.

464. **Advanced Human Bioclimatology.** Same as Physiology 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Geography 461. ARMSTRONG, SARGENT.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. 1 unit. Prerequisite: Geography 373 or consent of instructor. FOSTER.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. 1 unit. FOSTER.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. ½ to 2 units. Work may be taken in the following fields:

(a) **Anglo-American.** GARLAND.
(b) **Latin America.** ALEXANDER, THOMPSON.
(c) **Europe.** FOSTER, ROEPKE, RUSSELL.
(d) **Asia.** BOOTH, SHIMKIN.
(e) **U.S.S.R.** FELLMANN, SHIMKIN.
(f) **Australia and Oceania.** ARMSTRONG.
(g) **Economic Geography.** ROEPKE, RUSSELL, SHIMKIN.
(h) **Political Geography.** GARLAND.
(i) **Urban Geography.** FELLMAN.
(j) **Physical Geography.** ALEXANDER, ARMSTRONG, BOOTH.
(k) **Mathematical Geography.** ARMSTRONG, BOOTH, SHIMKIN.
(l) **Land Utilization and Conservation.** BOOTH, FOSTER, ROEPKE, SMITH.
(m) **Transportation Geography.** BOOTH, FELLMAN.
(n) **Problems of Geographic Study.** STAFF.
(o) **Africa.** ALEXANDER, FOSTER.
(p) **Medical Geography.** ARMSTRONG, CAVINS, NICHOLS.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. ½ unit. FELLMANN.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the acquisitions, care, and library use of maps. Classes become

familiar with the major cartobibliographical and related aids. ½ unit. Prerequisite: Consent of instructor. WHITE.

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. ¾ unit. Prerequisite: Geography 101 and 111. ARMSTRONG.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. ¾ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

323. **Geography of the North American Midwest.** The core of the North American continent; detailed analysis of the functions and patterns of the Midlands and their external relations. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. GARLAND.

332. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. ¾ unit. Prerequisite: Eight hours of geography or enrollment in Latin American studies program, or consent of instructor. THOMPSON.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. RUSSELL.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. ¾ unit. Prerequisite: Eight hours of geography, consent of instructor, or enrollment as a major or minor in Russian language and area studies. FELLMANN.

355. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

357. **Geography of the Middle East and North Africa.** A regional geography of an area with limits largely defined in terms of Arab and Moslem influences or closely related cultural and historical circumstances. The course is oriented around the strategic centrality of the core of the territory as the crossroads of Europe, Asia, and Africa. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. FOSTER.

361. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. ¾ unit. FOSTER, SMITH.

362. **Geography of Manufacturing.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. ¾ unit. Offered in 1966-1967 and in alternate years. ROEPKE.

363. **Geography of Minerals.** Geographic aspects of the mineral industries. ¾ unit. Offered in 1965-1966 and in alternate years. ROEPKE.

365. **Geography of Transportation.** A consideration of the agents of transportation (land, water, air), the routes of transportation, transportation terminal

complexes, and the basic commodity exchange services of transportation within the framework of their regional interregional relationships. ¾ unit. BOOTH.

366. **Location of Industry and Other Economic Activities: Theory and Practice.** Locational theory applied to the relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites. Study of factors affecting location of stores and other commercial activities. ¾ unit. FELLMANN, ROEPKE.

369. **Introduction to Human Ecology.** Same as Anthropology, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environtmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology and one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Quantitative Methods in Geography.** Geographical applications of statistical and mathematical research techniques. ¾ unit. Prerequisite: Geography 185, or one year of college mathematics, or one course in statistics, or the equivalent. ARMSTRONG.

371. **Introduction to Research.** Introductory training in bibliographical and cartographic techniques as source materials of geographic research. Limited to students whose major is geography and to seniors whose major is in other departments but who have twelve hours of geography. ¾ unit. FELLMANN, STAFF.

372. **Introduction to Research.** Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. ½ unit. STAFF.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. 1 unit. Prerequisite: Consent of instructor. FOSTER.

374. **Problems in Human Ecology.** Same as Anthropology, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Geography, Anthropology, Health Education, Physiology, Sociology, or Zoology 369. SHIMKIN, STAFF.

378. **Descriptive Interpretation of Remote Sensors.** Descriptive interpretation of remote sensors; descriptive interpretation of remote-sensing images with emphasis on interpretation of aerial photography; applications of aerial photography and photographic interpretation to the solution of problems in the major field of the individual student. Two half-day field trips on Saturdays will be required. 1 unit. Prerequisite: Consent of instructor. BOOTH.

381. **Russian Culture History and Ethnology.** Same as Anthropology 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. **Siberian Culture History and Ethnology.** Same as Anthropology 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. 1 unit. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; Western Hemisphere nations. ¾ unit. GARLAND.

GEOLOGY

Graduate students may take work in the Department of Geology leading to the Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, economic geology, geochemistry, geological oceanography, geomorphology and glacial geology, mineralogy and petrography, paleontology and stratigraphy, groundwater geology, sedimentation, and sedimentary petrography.

Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, geomorphology, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and mathematics.

A candidate for the doctor's degree may select a minor in chemistry, physics, mining or civil engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

GRADUATE FACULTY

Professors: G. W. WHITE (Head of Department), A. CAROZZI, C. A. CHAPMAN, D. U. DEERE, J. C. FRYE, R. E. GRIM, A. F. HAGNER, H. W. SCOTT, P. R. SHAFFER, H. R. WANLESS.

Associate Professors: J. M. DENNISON, W. W. HAY, D. M. HENDERSON, R. LANGENHEIM, A. F. RICHARDS, F. M. WAHL.

Assistant Professor: R. N. FARVOLDEN.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. 1 unit. Offered in 1966-1967 and in alternate years. WANLESS.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. 1 unit. Offered in 1965-1966 and in alternate years. WANLESS.

403. **History of Geology.** 1 unit.

409. **Sedimentation.** 1 unit. WANLESS.

415. **Geology of the Upper Mississippi Valley.** Field study of the geology of Illinois and adjacent states by means of five or six two-day field trips and the preparation of reports; estimated travel expense, $60.00. 1 unit. LANGENHEIM.

420. **Paleoecology.** Interpretation of life habit of fossil organisms from skeletal morphology and associated depositional features. Reconstruction of marine ecosystem relations from the study of assemblages of fossils. 1 unit. Prerequisite: Geology 320 or equivalent. HAY.

422. **Stratigraphic Geology: Paleozoic.** 1 unit. Prerequisite: Geology 321. SCOTT.

423. **Stratigraphic Geology: Mesozoic and Cenozoic.** 1 unit. Prerequisite: Geology 321. LANGENHEIM.

425. **Micropaleontology: Foraminifera.** Classification of microfossils, foraminifera; stratigraphic correlation. 1 unit. Prerequisite: Geology or Zoology 320. SCOTT.

426. **Micropaleontology: Ostracoda.** Classification of microfossils, ostracods, conodonts, scolecodonts, and other major groups; stratigraphic correlations. 1 unit. Prerequisite: Geology or Zoology 320. SCOTT.

428. **Palynology.** Same as Botany 428. The study of pollen and other spores, with emphasis on their evolution, paleoecological significance, stratigraphic application, and methods of preparation for study. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Geology 101 or Botany 120, or consent of instructor.

430. **Crystallography.** A consideration of the approaches and techniques required for an understanding of the structures and properties of crystals, especially those of minerals; emphasis is given to the development of pattern theory, space groups, and their applications. 1 unit. Prerequisite: Geology 335 or equivalent, and consent of instructor. HENDERSON.

431. **Structural Mineralogy.** Principles of the crystal chemistry and structural classification of minerals, and survey of the current knowledge about the structures and structurally dependent properties and behavior of representative minerals and mineral groups. 1 unit. Prerequisite: Geology 430 and consent of instructor. HENDERSON.

432. **Geochemistry.** A chemical approach to the interpretation of geological processes with emphasis on principles which control the distribution and migration of elements in geological environments. 1 unit. Prerequisite: Geology 336 or Chemistry 321, or equivalent; consent of instructor. WAHL.

435. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. 1 unit. CHAPMAN.

436. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied and special methods of investigation are covered. 1 unit. CHAPMAN.

437. **Sedimentary Petrology.** A study of sedimentary petrogenesis, including erosion, transportation, deposition, consolidation, diagenesis, and lithification. 1 unit. Prerequisite: Geology 335. RICHARDS.

438. **Sedimentary Petrography.** Microscopic study of sedimentary rocks in thin section with emphasis on textures and structures, as a basis for their detailed classification and genetic interpretation. 1 unit. Prerequisite: Geology 335 and 437. CAROZZI.

440. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. 1 unit. HAGNER.

443. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. 1 unit. Prerequisite: Geology 311. HAGNER.

444. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. 1 unit. Prerequisite. Geology 443. HAGNER.

450. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

455. **Hydrogeology.** The geology of the occurrence, storage, movement, and quality of water in the rocks of the Earth's crust. 1 unit. Prerequisite: Consent of instructor. FARVOLDEN.

461. **Mineralogy of Clays.** Same as Ceramic Engineering 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. **Mineralogy of Clays.** Same as Ceramic Engineering 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. GRIM.

473. **Geological Oceanography.** A survey of physical and chemical oceanography, with emphasis on their application to geologic problems; detailed treatment of selected geologic problems in marine sedimentation; and introduction to methods of observation and collection at sea. 1 unit. RICHARDS.

493. **Advanced Studies in Geology.** ½ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** GRIM, WAHL.
(b) **Engineering Geology.** DEERE.
(c) **Geomorphology and Glacial Geology.** SHAFFER, WHITE.
(d) **Ground-Water Geology.** FARVOLDEN.
(e) **Micropaleontology.** SCOTT.
(f) **Mineral Deposits.** HAGNER.
(g) **Mineralogy and Crystallography.** HENDERSON.
(h) **Paleobotany.** (See Botany 493j.) PHILLIPS, STEWART.
(i) **Paleontology.** HAY, SCOTT.
(j) **Pennsylvanian Stratigraphy.** WANLESS.
(k) **Petrography and Petrology.** CHAPMAN.
(l) **Sedimentary Petrology.** CAROZZI, RICHARDS, WANLESS.
(m) **Stratigraphy.** LANGENHEIM, SCOTT.
(n) **Submarine Geology.** RICHARDS.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Geomorphology.** The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. 1 unit. Prerequisite: Geology 102. SHAFFER, WHITE.

311. **Structural Geology.** Rock deformation and its results. Lectures, laboratory, and one two-day field trip. 1 unit. Prerequisite: Geology 102; General Engineering 205 or consent of instructor.

315. **Field Methods.** Mapping of an area in southern Illinois or western Kentucky during Easter vacation. Credit is given only on completion of a satisfactory written report. ½ unit. Prerequisite: Geology 102. WANLESS.

316. **Field Geology.** Geology of the Baraboo, Wisconsin, region. Field course covering structural, stratigraphic, glacial, and physiographic features. Emphasis is on methods of study and interpretation. A comprehensive report is required to provide training in geological report writing. Credit deferred until written report is submitted. S; 1 unit. Prerequisite: Geology 102 or equivalent; consent of instructor.

317. **Field Geology in the Rocky Mountains.** Field course conducted from a locality in the Rocky Mountains. Field training in stratigraphy, structure, and geomorphology; geologic mapping with a plane table and aerial photographs.

Approximate cost, $250 to $305. S; 2 units. Prerequisite: Geology 102; consent of instructor.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lectures and laboratory. 1 unit. Prerequisite: Geology 102. HAY.

321. **Stratigraphy.** Stratigraphy-fossil faunas, with special reference to invertebrates, correlation, and stratigraphy. 1 unit. Prerequisite: Geology 320. SCOTT.

324. **Vertebrate Paleontology.** Same as Zoology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Geology 102 or Zoology 132. BADER.

325. **Paleobotany.** Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Geology 101 and Botany 101 or Division of General Studies 131 and 132; or consent of instructor. STEWART.

335. **Optical Mineralogy.** Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is placed on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. 1 unit. Prerequisite: Geology 132. CHAPMAN.

336. **Petrography.** Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is placed on the ordinary methods of petrographical investigation. 1 unit. Prerequisite: Geology 335. CHAPMAN.

350. **Theoretical Geophysics.** An introduction to the major fields of theoretical geophysics: figure of the earth, thermodynamics of the earth, gravity, seismology, magnetism, and planetary geophysics. 1 unit. Prerequisite: Mathematics through calculus; one year of physics; Geology 311; consent of instructor.

351. **Geophysical Prospecting.** Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor. DE WITTE.

GERMANIC LANGUAGES AND LITERATURES

(Including German and Scandinavian)

The Department of Germanic Languages and Literatures offers work leading to the Master of Arts and Doctor of Philosophy. Students applying for admission must have a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Students should have completed a four-year course of undergraduate study in German corresponding to that of this University. They should be familiar with the principal works of the writers of the classical and modern periods of German literature, possess a general knowledge of the history of German letters and civilization, and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is highly desirable. A reading knowledge of French is required for advanced graduate work. A reading knowledge of one additional language, to be determined on the basis of the candidate's research needs, is required for admission to the third year of graduate study.

Fields of concentration for advanced degrees include German philology and linguistics, older literature, and modern literature.

Candidates for the Master of Arts in the Teaching of German must earn four units in German, two units in education, and two units in electives. Requirements

are: German, two or two and one-half units to be chosen from German 301, 302, 311, 312, 320, 331, 332, 415, or 416; one and one-half to two units from German courses open only to graduates; education, two units, including two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. The electives must be selected with the approval of the adviser.

GRADUATE FACULTY

Professors: J. R. Frey, P. M. Mitchell, E. A. Philippson, H. Stegemeier.
Associate Professors: H. G. Haile (Chairman of Department), F. J. Nock.
Assistant Professor: Pauline S. Schwalbe.

German

COURSES FOR GRADUATES

400. **Beginning German for Graduate Students.** Introduction to the reading of German texts in the sciences and the humanities. No graduate credit. Schwalbe.

401. **Readings in German for Graduate Students.** Designed for graduate students preparing for the German reading requirements for the Ph.D. No graduate credit. Prerequisite: German 400 or equivalent. Schwalbe.

411. **Proseminar.** Methods of literary criticism and research. 1 unit. Staff.

415. **Middle High German.** 1 unit. Nock.

416. **Middle High German Literature.** 1 unit. Prerequisite: German 415 or equivalent. Nock.

420. **History of the German Language.** 1 unit. Philippson.

426. **Gothic.** An introduction to Germanic (comparative) linguistics. 1 unit. Offered in 1965-1966 and in alternate years.

431. **German Literature of the Middle Ages.** German literature from 800 to 1400. 1 unit. Offered in 1965-1966 and in alternate years. Philippson.

432. **German Literature from 1400 to 1700.** Renaissance, Reformation, and Baroque in German literature. Lectures and readings. 1 unit. Offered in 1965-1966 and in alternate years. Philippson.

441. **German Romanticism.** 1 unit. Offered in 1965-1966 and in alternate years. Mitchell.

442. **Nineteenth-Century German Realism.** 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: German 301 and 302 or equivalent. Frey.

445. **Old High German.** Grammar and interpretation of the oldest literary documents. 1 unit. Offered in 1966-1967 and in alternate years. Philippson.

451. **Naturalism, Symbolism, Expressionism.** German literature from the 1880's to the 1920's. 1 unit. Offered in 1966-1967 and in alternate years. Frey.

452. **German Literature from the Twenties to the Present.** 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: German 301 and 302, or equivalent. Frey.

460. **Seminar in German Literature.** Advanced research work in German literature; discussion of problems and papers. 1 unit. Staff.

493. **Research in Special Topics.** 1 to 4 units. Staff.

495. **Bibliography and Methods of Literary History.** To be taken concurrently with German 411. ½ unit. Frey.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. German Literature to 1700. 1 unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

302. German Literature Since 1700. 1 unit. Prerequisite: German 210 and one other course in German literature. FREY.

303. Advanced Conversation, Composition, and Syntax. Extensive study of advanced problems of grammar, syntax, and style. ½ unit. Prerequisite: Three years of college German including German 212, or consent of instructor.

304. Advanced Conversation. Practice in free conversation with native speaker. No graduate credit. Prerequisite: German 303 or equivalent.

305. Modern German Poetry. A political and metrical survey of modern German lyric verse. 1 unit. Prerequisite: German 210 and one other literature course or its equivalent, or consent of instructor.

307. The Structure of the German Language. Study of the structure of the German language with emphasis on contrastive syntax of English and German. 1 unit. Prerequisite: German 210 and 212.

311. Goethe. Introduction to Goethe's life and works. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: German 210 and one other course in German literature. MITCHELL.

312. Goethe's Faust. Intensive study of Goethe's *Faust*, Parts I and II. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

320. History of German Civilization. A selected topical, historical, and pictorial analysis of German culture and civilization. 1 unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

331. The Age of Lessing. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

332. Schiller. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

360. Introduction to German Phonetics. ½ unit. Prerequisite: Consent of instructor. NOCK.

382. Language Laboratory Techniques. Same as French, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

Scandinavian

COURSES FOR GRADUATES

405. Old Norse-Icelandic, I. Grammar and selected readings. 1 unit. Offered in 1965-1966 and in alternate years. MITCHELL.

406. Old Norse-Icelandic, II. Readings. Selections from the Elder Edda and the sagas. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Scandinavian 405. MITCHELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. Ibsen. The dramas in English translation; selected works of Ibsen's Scandinavian contemporaries. 1 unit. Offered in 1965-1966 and in alternate years. MITCHELL.

362. **Strindberg and the Later Scandinavian Dramatists.** Major dramas and prose works of August Strindberg in translation; selected plays by Kaj Munk, Kjeld Abell, Nordahl Grieg, and Pär Lagerkvist. 1 unit. Offered in 1966-1967 and in alternate years. MITCHELL.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs renders advisory, consulting, and research services to the government of Illinois and their elected and appointed officials. Using the data acquired in these activities, the staff seeks, through scholarly and popular publication, to advance knowledge about the science of government and the political process.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of study leading to the Master of Science in Health Education. This program is centered in preparing teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for preparation in the special fields of public health education and safety education.

Admission requirements for a major in this field are: (1) a grade-point average of 3.75 (although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergaduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Requirements for the master's degree are eight units to include: (1) four units in health education or approved courses in physical education; (2) two units in education, including two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit; (3) satisfactory completion of Health Education 490, no credit; (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements but will be required to take two units' credit in lieu of thesis credit, and in addition, to pass a final comprehensive written examination in health education.

GRADUATE FACULTY

Professors: H. S. HOYMAN (Head of Department), W. H. CRESWELL, JR., A. E. FLORIO.

Associate Professors: F. E. BOYS, GERTRUDE B. COUCH, W. J. HUFFMAN.

Lecturers: C. A. BRIDGER, ISABELLE M. CRAWFORD, E. L. WITTENBORN, JR.

Health Education

COURSES FOR GRADUATES

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and principles as these apply to the further improvement of personal, family, and community health. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. HOYMAN.

401. **Problems in School Health Education.** History, philosophy, principles, and practices of school health education in its three main phases: health service,

healthful school environment, and health instruction, including evaluation. 1 unit. CRESWELL, HOYMAN, HUFFMAN.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. 1 unit. COUCH.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. HOYMAN, HUFFMAN.

490. **Seminar.** Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. No credit. STAFF.

493. **Special Projects.** Independent research. Open only to candidates for the Doctor of Philosophy. ½ or 1 unit. Prerequisite: Educational Psychology 390, Physical Education 495, and Health Education 400, or equivalent. STAFF.

499. **Thesis Research.** Preparation of theses in health and safety education. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology and one year of anthology, geography, geology, or sociology. SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. LEVINE, STAFF.

390. **Public Health Education.** Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers. Projects in preparing and using public health education materials. Evaluation of research in public health education. ½ unit. Prerequisite: Consent of instructor. COUCH.

391. **Public Health Statistics.** An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. ½ unit. Prerequisite: Mathematics 161 or Educational Psychology 390, or equivalent. BRIDGER.

Safety Education

COURSES FOR GRADUATES

402. **Problems in Safety Education.** Philosophy of safety; traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to

education; organization of safety education programs; methods of teaching; legal aspects; research problems. 1 unit. FLORIO, HUFFMAN.

HISTORY

The Department of History offers work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work in history presupposes two years of undergraduate study in this subject, or a minimum of sixteen semester hours, including courses in European and American history. Undergraduate linguistic preparation, especially in French, German, or Russian, is important. For ancient and medieval history, some knowledge of Greek or Latin may be essential. Spanish is useful for certain fields of European, American, and Latin-American history.

Admission to graduate study in history requires a grade-point average of at least 4.0 for the last sixty hours of undergraduate study. Students with averages below 4.0 but above 3.75 are considered on an individual basis. A student who has done graduate work in a recognized institution but without receiving a degree may petition to receive credit toward an advanced degree by passing examinations in this work.

Master of Arts. During his first term, each candidate must pass a comprehensive qualifying examination in three of the following six areas: ancient, medieval, modern Europe after 1500, English, American, and Near and Far Eastern. Special provisions may be made for those who did not major in history in an American college or university. Candidates are expected to take at least two units in two of the above fields of specialization. A minimum of eight units is required for the Master of Arts and three of these units must be at the 400 level. The program must include History 495 and two research seminars with grades of B or better. Students may elect to write a master's thesis, but the thesis will not replace the seminar requirement. Candidates must demonstrate a reading knowledge of one foreign language—French, German, or Russian—by passing an examination administered by the language department.

Graduate study in history may also be pursued in connection with the Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see page 313).

Doctor of Philosophy. The Department of History offers the following fields of specialization and preparation: ancient Greece; ancient Rome; medieval, to 1300; Europe, 1300-1648 (Renaissance and Reformation); Europe and dependencies, 1648-1815; Europe and dependencies since 1815; Russia; England to 1688; England and the Empire-Commonwealth since 1688; Near East and Middle East; China; South Asia; early America to 1789; United States since 1789; Latin America; history of science.

Candidates who have not previously taken the department's comprehensive qualifying examination are required to do so during their first semester of doctoral study. A candidate must demonstrate ability to read two of the following languages: French, German, Russian. A student who has not passed the examination in one language will not be readmitted to a second year of graduate study. No student will be recommended for financial aid of any kind for a third year of study who has not passed both language examinations.

Two research seminars are required for all candidates if these were not taken here in the master's progam. History 495 or equivalent, and History 496 and 498 also are required. The doctorate requires a minimum of sixteen units beyond the master's degree. Eight of these may be thesis research credit.

Candidates must offer five fields of preparation for their preliminary examination; four in history and one in a related subject. The major field in which the thesis is to be written requires a minimum of four units; the first minor field, a minimum of three units; and the others, two units each. Fields other than those listed above may be accepted in individual cases.

The second minor field may be selected from the following departments and areas: political science, economics, education, sociology, philosophy, and literature. Other suitable second minors may be arranged.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor, three units, in American literature, and a second minor, two units, in the history of fine arts in the United States.

Illinois Historical Survey. Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, students in history are able to obtain useful training in the study of manuscript as well as printed materials.

GRADUATE FACULTY

Professors: R. W. Johannsen (Chairman of Department), C. E. Dawn, E. L. Erickson, R. T. Fisher, Jr., D. Geanakoplos, N. A. Graebner, H. M. Hyman, M. D. Lee, Jr., C. E. Nowell, P. W. Schroeder, C. C. Spence, C. G. Starr, R. P. Stearns, R. M. Sutton.

Associate Professors: J. L. Bates, J. A. Nichols, J. B. Sirich, W. U. Solberg.

Assistant Professors: R. B. Crawford, R. O. Crummey, R. A. Friedlander, B. D. Hill, H. H. Kaplan, R. H. Kargon, B. B. Kling, R. F. Kuisel, R. M. McColley, R. A. Waller, G. M. Wilson.

COURSES FOR GRADUATES

401. Seminar in Medieval History. 1 unit. Geanakoplos.

409. Early Modern Europe to 1815. A graduate survey of problems and sources. 1 unit. Lee.

410. Modern Europe Since 1815. A graduate survey of problems and sources. 1 unit. Nichols.

411. The French Revolution and Napoleon. A seminar in the history of France and her relations with Europe, 1789 to 1815. 1 unit. Sirich.

414. Seminar in Modern History: The Enlightenment. 1 unit. Prrequisite: Reading knowledge of one major European language other than English. Stearns.

415. Seminar in the History of Europe Since 1815. 1 unit. Nichols.

419. Seminar in Modern Russian History. 1 unit. Fisher.

431. Seminar in English History. 1 unit Erickson.

432. Seminar in English History. 1 unit. Lee.

452. Seminar in American History. 1 unit. Johannsen.

453. Seminar in the Social and Economic History of the United States. 1 unit. Spence.

456. Seminar in American Diplomatic History. 1 unit. Graebner.

457. Seminar in Early American History Before 1763. A research seminar in aspects of the founding and growth of the British colonies of North America. 1 unit. Prerequisite: Consent of instructor. Stearns.

458. Seminar in American History: The Revolutionary Period. 1 unit. Stearns.

461. Seminar in Recent American History. 1 unit. Bates.

471. Seminar in the Constitutional History of the United States. 1 unit. Hyman.

472. Seminar in the Intellectual History of the United States. 1 unit. Solberg.

473. Graduate Survey of American History to 1865. 1 unit. Johannsen.

474. Graduate Survey of American History Since 1865. 1 unit.

476. **Seminar in Latin American History: The Revolutionary Period.** 1 unit. NOWELL.

482. **Seminar in Ancient History.** 1 unit. STARR.

495. **Historical Method.** Required of all candidates for an advanced degree in history who do not present evidence of similar training elsewhere. 1 unit. STAFF.

496. **History of Historiography.** Introduction to the great historians from early times to the present. 1 unit. STARR.

497. **Reading Course.** Directed reading in special fields. Open only to students with a master's degree or equivalent, who are preparing for the preliminary examination in history and who need instruction in areas not provided by current course offerings. 1 unit. Prerequisite: Master's degree or equivalent; consent of instructor. STAFF.

498. **Problems in the Teaching of College History.** No credit. Prerequisite: Candidate for Ph.D. degree in history. STAFF.

499. **Thesis Research.** Individual direction in research and guidance in writing theses for advanced degrees. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The general prerequisite for all graduate students registering in 300-numbered courses is one year of college history or consent of instructor.

301. **The Middle Ages from 400 to 1100 A.D.** Europe from the fall of Rome to the first crusade. ½ or 1 unit. GEANAKOPLOS.

302. **The Middle Ages from 1100 to 1500 A.D.** Europe from the rise of towns to the establishment of national monarchy. ½ or 1 unit. GEANAKOPLOS.

303. **History of Byzantine Civilization.** A study of cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D. to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. ½ or 1 unit. GEANAKOPLOS.

304. **Medieval Civilization.** Religious and intellectual. ½ or 1 unit. Prerequisite: One year of college history or political science. GEANAKOPLOS.

305. **The Age of the Renaissance.** ½ or 1 unit. GEANAKOPLOS.

306. **The Age of the Protestant and Catholic Reformation, 1500-1648.** ½ or 1 unit. LEE.

307. **Classical Islam: The Near East from Mohammed to the Crusades.** ½ or 1 unit. DAWN.

308. **The Europeanization of the Near East, 1768-1914.** ½ or 1 unit. DAWN.

309. **Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789.** ½ or 1 unit. SIRICH.

310. **Development of Modern Europe: The French Revolution and Napoleon, 1789-1815.** ½ or 1 unit. SIRICH.

311. **European History from 1815 to 1871.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

312. **European History from 1871 to 1918.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

313. **European History from 1918 to 1939.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KUISEL.

314. **European History from 1939 to the Present.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KUISEL.

318. **Modern European Diplomatic History, 1789-1890.** The diplomatic history of Europe from the French Revolution to the fall of Bismarck. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. SCHROEDER.

319. **Modern European Diplomatic History, 1890 to the Present.** The diplomatic history of Europe from the fall of Bismarck to the present day. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. SCHROEDER.

320. **Russia from the Earliest Times to Peter the Great.** The political, economic, cultural, and social development of Russia during the Kievan and Muscovite periods. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. KAPLAN.

321. **Russia from Peter the Great to 1855.** The political, economic, cultural, diplomatic, and social development of Russia during Imperial times. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. KAPLAN.

323. **Intellectual History of Modern Europe, 1513-1770.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. SIRICH.

324. **Intellectual History of Modern Europe, 1770 to the Present.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. SIRICH.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

327. **The Russian Revolution.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

328. **History of Soviet Russia from 1917 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

329. **History of East Central Europe to 1815.** Survey of the political and cultural developments of the Western Slavs and their Baltic and Danubian neighbors, from the origin of the kingdoms of Poland, Bohemia, and Hungary to the Congress of Vienna. ½ or 1 unit. KAPLAN.

330. **History of East Central Europe from 1815 to the Present.** The development of nationalism in East Central Europe since the Congress of Vienna; the Revolutions of 1848; the growth of nationalism and the struggle for independence; the establishment of national states; the First World War and Versailles; the inter-war period; the Second World War and the Communist take-over. ½ or 1 unit. KAPLAN.

333. **Great Britain Under the Tudors and Stuarts, 1485-1660.** This course traces the principal political, economic, social, religious, and cultural developments in British history, including Scotland and Ireland, from the beginning of the Tudor dynasty to the Restoration of 1660. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. LEE.

334. **Great Britain Under the Later Stuarts and the Hanoverians, 1660-1815.** This course traces the principal political, economic, social, religious, and cultural developments in British history from the Restoration to the end of the Napoleonic wars. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. LEE.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and Economics 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics of American history. SCHWEITZER.

339. **History of the British Commonwealth in the Nineteenth Century, 1783-1900.** ½ or 1 unit. ERICKSON.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** ½ or 1 unit. ERICKSON.

341. **Modern Britain: The Victorian Era, 1815-1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. Offered in 1965-1966 and in alternate years. ERICKSON.

342. **Modern Britain Since 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. Offered in 1965-1966 and in alternate years. ERICKSON.

345. **Constitutional History of England to 1485.** ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

346. **Constitutional History of England, 1485 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

347. **The Emergence of Modern Science to the Age of Newton.** A history of science from ancient times to the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. KARGON.

348. **The History of Modern Science Since the Age of Newton.** The development of the sciences and scientific principles since the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. KARGON.

352. **Colonial Beginnings of American Life and Institutions.** A study of the seventeenth- and eighteenth-century colonies. ½ or 1 unit. STEARNS.

354. **The Era of the American Revolution, 1763-1789.** ½ or 1 unit. STEARNS.

355. **Federalists, Jeffersonians, and the Era of Good Feelings.** United States history from 1789 to 1828 with emphasis on the conflict between nationalism and sectional interests. ½ or 1 unit. MCCOLLEY.

356. **History of the United States, Jackson to the Civil War.** Study of Jacksonian democracy; the rise of sectionalism; manifest destiny and the Mexican War; the issue of slavery and expansion and the approach of the Civil War. ½ or 1 unit. JOHANNSEN.

357. **Social and Economic History of the United States, 1775-1860.** The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. ½ or 1 unit. SPENCE.

358. **Social and Economic History of the United States Since 1860.** The growth of American economic life and institutions since 1860. ½ or 1 unit. SPENCE.

359. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. ½ or 1 unit. JOHANNSEN.

360. **History of the United States, 1877-1909.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

361. **History of the United States, 1909-1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

362. **History of the United States Since 1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics.

363. **American Political Parties to 1888.** The history of American political parties to 1888, their impact on American society, and the major events which the parties helped to shape. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

364. **American Political Parties Since 1888.** Shifts in voting behavior, changing techniques of campaigning, characteristics of political leaders, and the impact of foreign policy on the structure of political parties. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

365. **The History of Illinois to 1870.** Evolution of a typical midwestern commonwealth, with emphasis upon its political, economic, social, religious, and cultural development in the nineteenth century. ½ unit. SUTTON.

366. **The History of Illinois from 1870 to the Present.** The evolution of a modern American state, with emphasis upon its political life, economic growth, social and intellectual problems, and its contribution to the American nation. ½ unit. SUTTON.

367. **The Trans-Mississippi West.** The history of Western expansion since the Louisiana Purchase. The West in the general history of the United States; Western economic and political problems. ½ or 1 unit. SPENCE.

368. **History of the South.** An inquiry into the question, when did the South begin and what have been its distinguishing traits? Special attention is given to agrarianism, industrialization, and the race problem. ½ or 1 unit. BATES.

369. **Constitutional Development of the United States to 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science. HYMAN.

370. **Constitutional Development of the United States Since 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science. HYMAN.

371. **American Intellectual and Cultural History to 1877.** Social and political thought, religion, science, scholarship, and education as both results and causes of American experience. ½ or 1 unit. SOLBERG.

372. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. ½ or 1 unit. SOLBERG.

373. **Diplomatic History of the United States to the End of the Nineteenth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science. GRAEBNER.

374. **Diplomatic History of the United States in the Twentieth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science. GRAEBNER.

375. **History of Latin America to 1824.** A survey of Latin American history from the discovery of America until 1824. ½ or 1 unit. NOWELL.

376. **Latin America Since 1824.** A history of the Latin American republics from their independence to the present. ½ or 1 unit. NOWELL.

381. **Ancient Greek States.** History of the Greek states from the earliest times to 334 B.C. ½ or 1 unit. STARR.

382. **Alexander and His Successors.** ½ or 1 unit. STARR.

383. **History of the Roman Republic to 44 B. C.** ½ or 1 unit. STARR.

384. **The Roman Empire.** ½ or 1 unit. STARR.

387. **Indian History and Civilization to 1707.** Development of Indian civilization up to the British conquest. Political evolution; religious and philosophical systems; society, art, and literature during Hindu and Muslim periods. ½ or 1 unit. KLING.

388. **Development of Modern India and Pakistan from 1707.** Establishment and organization of the British Empire in India; reaction of India to the Western impact; growth of nationalism and the struggle for independence. ½ or 1 unit. KLING.

389. **Problems of Contemporary South Asia.** Current political, economic, social, and cultural problems of India, Pakistan, and Ceylon dealt with in the perspective of the historical development of South Asia. ½ or 1 unit. KLING.

391. **A History of China to 906 A.D.** A history of the formative period of the Chinese state, society, and economy. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. CRAWFORD.

392. **A History of China, 907-1840.** A history of the early modern Chinese state and society prior to the Western impact. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. CRAWFORD.

393. **Chinese Intellectual History from Earliest Times to the Present.** A study of the major ideas and schools of thought as they have affected the course of Chinese history and the development of its institutions. ½ or 1 unit. CRAWFORD.

394. **Modern China, China Since 1840.** A study of China's response to the Western impact, with special emphasis on the Nationalist revolution, and the rise of the Communist party of China and its domestic and foreign policies. ½ or 1 unit. CRAWFORD.

395. **A History of Japan to 1867.** The political, economic, social, and cultural development of Japan from its formative and feudal periods to the Meiji restoration. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. WILSON.

396. **A History of Japan Since 1867.** The political, economic, social, and cultural development of Japan from the Meiji restoration to the present. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor. WILSON.

HOME ECONOMICS

The Department of Home Economics offers work leading to the Master of Science or Master of Arts in Home Economics; Master of Science in Home Economics Education; and Doctor of Philosophy in Home Economics with a major in foods and nutrition. The major work for a master's degree in home economics may be done in one of six curricula as shown below. The minimum grade-point average for admission to graduate study in home economics and home economics education is 3.75. Applications of students with averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science or Master of Arts. Candidates for a master's degree in home economics must complete a minimum of eight units (nine if a thesis is not submitted), of which at least four must be in home economics. Four of the total units, including at least two in home economics, must be in 400-level courses.

Lists of suggested electives for each curriculum are available from the department upon request. Required courses for each of the six curricula are given below:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 305, 410, 418, 419, and 499.

(2) *Family and Consumption Economics.* A minimum of four units from Home Economics 370, 379, 470, 499, with credit in Home Economics 370 and 499 required. A minimum of two units from Economics 300, 301, 400-401, or 402-403.

(3) *Family Housing and Household Management.* A minimum of nine units; two from Home Economics 361, 370, 375, 378, 379, and 470; Agricultural Engineering 300, and Architecture 339; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from Urban Planning 372, Economics 313, Finance 369, Sociology 407, 476, 477.

(4) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499; also, Chemistry 354 or 350 and 355 are required.

(5) *General Home Economics.* A minimum of four units from prescribed courses in three of the other five curricula in home economics.

(6) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 395, 480, 487, and 499.

Candidates for the Master of Science in Home Economics Education must earn eight units, four of them in home economics. Three units must be in 400-numbered courses and at least one of these must be in home economics. Courses in home economics are to be chosen from Home Economics 301, 320, 322, 323, 326, 330, 331, 361, 375, 378, 379, 380, 386, 388, 395, 410, 418, 419, 480, and 487; Educational Psychology 311 and 312, one unit; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; Vocational and Technical Education 453, one unit; Vocational and Technical Education 456, one unit, or Home Economics 377, one-half to one unit.

Doctor of Philosophy. Candidates for this degree with a major in foods and nutrition must present an undergraduate foods course with an organic chemistry prerequisite; a nutrition course with organic chemistry and physiology prerequisites; adequate training in chemistry, including quantitative analysis and organic; and introductory courses in microbiology, physics, and trigonometry. A student emphasizing foods in the doctoral program should have had a course in colloid chemistry. Deficiencies in these requirements may be made up during the first year of graduate study.

Required courses include at least three units of foods and nutrition, two at the 400 level; one unit of statistical methods at the 400 level; courses in biochemistry and physical chemistry; and an advanced course in food microbiology or mammalian physiology. Additional courses in the above areas or in animal nutrition or food science are selected to satisfy major unit requirements. Candidates may minor in animal nutrition, biochemistry, food science, microbiology, physiology, and other appropriate areas. Either foods or nutrition is emphasized in research for the thesis.

Graduate students who choose an area of home economics as a minor for the Doctor of Philosophy must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in 400-level courses.

GRADUATE FACULTY

Professors: Janice M. Smith (Head of Department), Ruth L. Galbraith, Pearl Janssen, Frances Van Duyne.

Associate Professors: Mildred Bonnell, Marilyn M. Dunsing, Margaret Goodyear, Beulah Hunzicker, Queenie B. Mills, Lorraine D. Trebilcock.

Assistant Professors: Karlyne Anspach, Shirley M. Clark, Elsie M. Crouthamel, Glenna H. Lamkin, Beula V. McKey, Willie Mae Mowrer.

COURSES FOR GRADUATES

410. **Problems in Family Living.** Family relationships and their significance to the growth of family members. 1 unit. Prerequisite: Home Economics 210. Mowrer.

418. **Seminar in Child Development.** Advanced problems in child development. 1 unit. Prerequisite: Home Economics 301. Mowrer.

419. **Seminar in Family Relationships.** Critical evaluation of research literature in the field of marriage and family relationships. 1 unit. Prerequisite: Home Economics 410. Mowrer.

422. **Seminar in Nutrition.** A study of recent literature in nutrition. ½ or 1 unit. Prerequisite: Undergraduate degree in home economics, with emphasis on foods and nutrition, or comparable background in biochemistry, microbiology, physiology, or other biological science.

423. **Problems in Human Nutrition.** Methods of assessing nutritional status of humans. ½ or 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Home Economics 324 or equivalent.

430. **Carbohydrates in Foods.** Same as Food Science 430. A study of the physical and chemical properties of carbohydrates used in food and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 354 or 350 and 355, or consent of instructor.

432. **Seminar in Foods.** Review of current literature in foods research. ½ or 1 unit. Prerequisite: Undergraduate major in foods and nutrition, chemistry, microbiology, or physiology; consent of instructor. VAN DUYNE.

470. **Seminar in Family and Consumption Economics.** Same as Agricultural Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in applied statistics; Home Economics 370 or consent of instructor. DUNSING.

480. **Seminar in Textiles.** Current literature related to development in the production, use, and care of textile fabrics. ½ or 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. GALBRAITH.

487. **Seminar in Clothing.** Study and discussion of research in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. ½ or 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. ANSPACH.

493. **Advanced Studies in Home Economics.** Library or experimental research on specific problems of limited scope. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. This is one of the courses which may be taken in addition to eight units required for a master's degree by students who do not write a thesis. ½ or 1 unit. STAFF.

499. **Thesis Research.** Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. 0 to 4 units. CLARK, DUNSING, GALBRAITH, MILLS, MOWRER, SMITH, VAN DUYNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. ½ or 1 unit. Prerequisite: Home Economics 202 and 203; consent of instructor. MOWRER.

305. **Human Heredity.** Heredity in man and its relation to various individual and social problems. Lectures, discussions, and demonstrations. Graduate credit does not count toward a major in genetics. ½ unit.

313. **Economics of Consumption.** Same as Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

320. **Diet in Disease.** ½ unit. Prerequisite: Home Economics 220.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. ½ unit. Prerequisite: Home Economics 220; consent of instructor.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition. Readings, lectures, and discussions, S; ½ unit. Prerequisite: Chemistry 132 or 133; Physiology 103; Home Economics 220 and 231. McKey, Van Duyne.

324. **Problems in Nutrition.** Discussions and investigations. ½ or 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing. McKey.

326. **Demonstration Problems and Techniques.** Consideration of the techniques of demonstrations and problems involved. ½ unit. Prerequisite: One of the following: Home Economics 231, 262, 270, 301, 375, 379, 380, 386; or consent of instructor. Lamkin.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. ½ or 1 unit. Prerequisite: Home Economics 231; Microbiology 100 and 101. Janssen.

331. **Problems in Foods.** Individual problems in food preparation and preservation. ½ unit. Prerequisite: Home Economics 330. Van Duyne.

345. **Institution and Restaurant Management: Food Purchasing and Equipment Selection.** Purchasing food and selecting equipment for quantity food service; factors affecting the purchase of food, relationship of floor plans and equipment to service. ½ unit. Credit is not given for both Home Economics 345 and 351. Prerequisite: Credit or registration in Home Economics 240; Economics 108. Bonnell.

350. **Institution and Restaurant Management: Organization and Administration.** The organization and administration of food service operations; management problems in various types of food service, personnel, costs, sanitary control. Field trips: estimated expense, $50.00. ½ or 1 unit. Credit is not given for both Home Economics 350 and 351. Prerequisite: Home Economics 220 and 240. Hunzicker.

351. **Special Problems in Group Feeding.** For individuals interested in refreshing and strengthening knowledge in group feeding. Lectures, discussions, laboratory practice in quantity food management. Food handler's certificate required. No credit for students who have completed Home Economics 240, 345, or 350. S; ½ unit. Prerequisite: Home Economics 220 and 231, or equivalent; consent of instructor. Bonnell.

355. **Specialized Quantity Food Production and Management.** Advanced application of food production and management principles to special food service demands. Emphasis on artistry in preparation, serving, and merchandising high quality food in quantity. ½ unit. Prerequisite: Home Economics 240, credit or registration in Home Economics 350, or consent of instructor. Bonnell.

361. **Development and Function of Family Housing.** Same as Agricultural Engineering 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ½ unit. Prerequisite: Home Economics 160, 171, or consent of instructor. Hansen.

370. **Family Economics.** Same as Agricultural Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. Dunsing.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equip-

ment and equipment performance tests. ½ unit. Prerequisite: Home Economics 171; six advanced hours in home economics, including one of the following: Home Economics 231, 273, 380; consent of instructor.

377. **Home Economics Extension.** History and development; types of county organizations, objectives; extension teaching tools; county program determination and evaluation. Field trips. ½ or 1 unit. Prerequisite: Consent of instructor.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the fields of family housing, home furnishings, and home management. ½ to 1 unit. Prerequisite: Home Economics 262 or 270; consent of instructor. GOODYEAR.

379. **Problems in Family and Consumption Economics.** Individual investigation of specific problems in the field of family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics; Home Economics 370 or consent of instructor. DUNSING.

380. **Advanced Textiles.** The effect of the physical and chemical structures of textile fibers on their properties, manufacturing processes, use, and care. 1 unit. Prerequisite: Home Economics 183; Chemistry 132. CROUTHAMEL, GALBRAITH.

386. **Clothing Design: Draping.** Designing by draping, inspired by appropriate design sources; understanding of fitting principles through fabric manipulations; design effects maintained in garment construction. 1 unit. Prerequisite: Home Economics 285 or consent of instructor; Home Economics 286. ANSPACH.

388. **Problems in Textiles and Clothing.** Investigation and report of individual problems in the field of textiles and clothing. ½ or 1 unit. Prerequisite: Home Economics 286 or 380 or Marketing 211; consent of instructor. ANSPACH, CROUTHAMEL, GALBRAITH, TREBILCOCK.

395. **Fashion Analysis.** A study of fashion terminology, selected designers, garment manufacturing techniques, and methods of fashion promotion used in retail outlets. Field trip; estimated expense, $10.00. ½ unit. Prerequisite: Advertising 281; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy. Candidates may specialize for either degree in floriculture, plant breeding, pomology, or vegetable crops.

The required grade-point average for admission to graduate study in horticulture is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Twenty hours of undergraduate work in horticulture and allied subjects are required of students who choose horticulture as a major, and twelve hours are required of those who select it as a minor. The department waives certain of these requirements for some fields of major study if the student has had an equivalent preparation in the fundamental sciences. It is desirable, when the major field of study is decided upon during the junior or senior year, to select the fundamental science courses accordingly and, if possible, to include in the undergraduate preparation the elementary courses in German or French.

Advanced work in agricultural economics, agronomy, botany, chemistry, entomology, genetics, or plant pathology may be taken advantageously with horticulture to make a well-balanced course of graduate study.

GRADUATE FACULTY

Professors: C. J. Birkeland (Head of Department). C. Y. Arnold. J. B. Gartner, M. B. Linn, R. V. Lott, J. P. McCollum, D. Powell, A. E. Thompson, J. S. Vandemark.

Associate Professors: H. C. Barrett, J. R. Culbert, D. F. Dayton, E. R. Jaycox, R. K. Simons, J. S. Titus.

Assistant Professors: L. Beevers, D. B. Dickinson, T. K. Hodges, A. M. Rhodes, C. C. Zych.

COURSES FOR GRADUATES

424. **Mineral Nutrition of Plants.** Same as Agronomy and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. Hageman.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Dairy Science, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Dairy Science, and Veterinary Medical Science 441. A continuation of Horticulture 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Horticulture 440 or equivalent.

447. **Horticulture Seminar.** Discussion of current research and literature pertaining to problems of horticulture and related fields. ¼ unit. Staff.

490. **Research Methods in Horticulture.** Lectures, discussions, demonstrations, and laboratory exercises dealing with methods and apparatus used in horticultural research. 1 unit. Prerequisite: Chemistry 133 or equivalent; Chemistry 122 or equivalent; Botany 330; five hours of physics. Staff.

492. **Special Topics in Horticulture.** Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. ½ to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

499. **Thesis Research.** Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **Floricultural Physiology.** A study of the physiology and metabolism of floricultural crops during their development from seeds through flowering. Lectures and discussion. 1 unit. Prerequisite: Botany 230 and 231 or equivalent, and one semester of organic chemistry. Beevers.

322. **Plant Nutrition.** A study of the mechanisms of and factors affecting the absorption, transport and functions of the essential elements required by higher plants. Lectures, discussions, and laboratory. 1 unit. Prerequisite: Botany 230 and 231 or equivalent, and one semester of organic chemistry. Hodges.

323. **Principles of Plant Breeding.** Same as Agronomy 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, the maintenance of high quality seed stocks. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. HADLEY, HITTLE, THOMPSON.

335. **Economics of Food Distribution.** Same as Agricultural Economics 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. KELLY.

345. **Growth and Development of Horticultural Crops.** Factors affecting growth, development, and quality of vegetable crops. Lecture and discussion. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Botany 230 or equivalent, or consent of instructor. MCCOLLUM.

361. **Individual and Group Behavior of Honey Bees.** Study of individual and group behavior of honey bees, their biological value, physical basis, and evolution. Lectures and discussions, one or more local field trips, term paper, and assigned reading. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

HUMANITIES

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Comparative Literature, I.** A comparative study of great books in Greek, Roman, Italian, and Spanish literature. ½ unit.

364. **Introduction to Comparative Literature, II.** A comparative study of great books in French, German, and Russian literature. ½ unit.

INDUSTRIAL ADMINISTRATION

The Department of Industrial Administration offers graduate work either as a major or a minor leading to the Master of Science in management, and as a minor for the Doctor of Philosophy.

Admission requires a grade-point average of 3.75 for the last sixty hours of undergraduate study. Candidates with a grade-point average between 3.5 and 3.75 may be considered on an individual basis. Such students may be required to take an appropriate examination such as the Admission Test for Graduate Study in Business (fee $10.00).

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration and related subjects. To do minor work in this field, at least twelve hours of work in business administration and related subjects are required.

GRADUATE FACULTY

Professors: E. J. DEMARIS (Head of Department), P. M. DAUTEN, JR., P. M. GREEN, E. G. PLANTY, P. C. ROBERTS.

Associate Professors: R. L. BLACK, R. N. CORLEY, B. F. KIRKPATRICK, S. YOUNG.

COURSES FOR GRADUATES

401. **Scientific Management—Qualitative.** A study of modern management principles, functions, processes, and activities, with major emphasis upon developing a scientific body of administrative knowledge. 1 unit.

402. **Scientific Management—Quantitative.** A study and analysis of the quantitative techniques and controls available to modern management, with major emphasis upon integrating qualitative and quantitative management concepts. 1 unit.

416. **Problems in Business Policy.** Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. 1 unit. Prerequisite: Consent of instructor.

448. **Problems of Personnel Management.** Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. This course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 248 or equivalent, or consent of instructor.

449. **Problems of Personnel Management.** Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Industrial Administration 248, 448, or equivalent.

491. **Seminar in Special Topics.** For lectures in topics of current interest not covered by regular course offerings. Subjects will be announced in the Time Table. ¼ to 1 unit. Prerequisite: Consent of instructor or department head.

499. **Thesis Research.** 1 unit. DeMaris.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Business Torts.** Liability of businessmen for their wrongful acts and those of their agents arising separate and apart from their liabilities under contracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, including breach of contract. ¾ or 1 unit. Prerequisite: Business Law 100 or Industrial Administration 200. Kirkpatrick.

301. **The Law of Security Transactions and Banking.** Significant phases of law in the fields of pledges, chattel mortgages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. ¾ or 1 unit. Prerequisite: Business Law 100 or Industrial Administration 200.

302. **Wills, Estates, and Trusts.** A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. ¾ or 1 unit. Prerequisite: Business Law 100 or Industrial Administration 200.

311. **Administrative Policies and Organization.** Development of administrative organization and the determination of policies for the integration of major activities of a business enterprise. ½ or ¾ unit. Prerequisite: Industrial Administration 101 and Marketing 101.

312. **Human Relations in Business.** Same as Labor and Industrial Relations 312. Problems of the individual and groups brought about by modern industrial

organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. ½ or ¾ unit. Prerequisite: Industrial Administration 101 or equivalent.

315. **Management in Manufacturing.** Internal problems of production and efficient control in factories. ½ unit. Prerequisite: Industrial Administration 101.

320. **Organization Theory and Practice.** A study of the means used to achieve coordinated effort toward the accomplishment of objectives. Includes a consideration of both "classical" concepts for the division and integration of work through formal organizational structures along with behavioral science concepts of the forces that draw people into groups and the factors which aid or hinder their collective effectiveness. The principle objective is to give the student knowledge of the processes of analyzing and planning organizations to accomplish business objectives. ½ or ¾ unit. Prerequisite: Industrial Administration 312.

JOURNALISM

The Department of Journalism offers graduate work leading to the Master of Science in Journalism. For the program leading to the Doctor of Philosophy in Communications, see page 109.

Admission to graduate work in journalism requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in jounalism or a related field such as English or the social sciences; and (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Requirements for the master's degree include:

(1) A major of four units, or three units and one additional unit approved by the department. Candidates without acceptable undergraduate majors may be required to complete (a) one unit of Journalism 321, (b) one unit of advanced undergraduate courses in writing or editing, and (c) in individual cases, some combination of Journalism 204, 211, 223, and 291, without graduate credit.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A thesis of one unit (Journalism 499) or the preparation of a topic of general public interest for publication or broadcast (Journalism 490).

(4) A minimum of three units in courses at the 400 level, at least two of which must be in the major field.

(5) A comprehensive written examination in the student's major and minor fields and on the current master's reading list.

(6) A minimum total of eight units.

GRADUATE FACULTY

Professor: T. Peterson.

Associate Professors: J. W. Jensen (Head of Department), G. G. Hanson, H. S. Maclay, J. H. Schacht.

Assistant Professors: R. L. Brown, J. W. Carey, A. E. Strang.

COURSES FOR GRADUATES

468. **The Political Economy of Communications.** Same as Communications 468. Analysis of theory and problems concerning such social agencies of communica-

tion as telephone, radio services (including television), and motion pictures, with special emphasis on their policies and structures. 1 unit.

470. Communications and Popular Culture. Same as Communications 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit. BROWN.

471. Proseminar in Communications, I. Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. 1 unit. CAREY, STAFF.

472. Proseminar in Communications, II. Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. MACLAY, STAFF.

473. History and Theory of Freedom of the Press. Same as Communications 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. CAREY, JENSEN.

474. Communications Systems. Same as Communications 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. CAREY.

490. Special Topics in Journalism. ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

492. Research Methods in Communications. Same as Communications 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in journalism. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. High School Journalism. Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. ½ unit. Prerequisite: History and Philosophy of Education 201 or consent of instructor. GILMORE.

311. Law and the Press. The historical background of the nature and meaning of the law as it relates to journalism and contemporary problems of freedom of expression. ½ unit.

321. News Editing. Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and makeup and design of newspaper pages. 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212 or consent of instructor. SCHACHT.

323. Advanced Reporting. Advanced types of news investigation and treatment. ½ unit. Prerequisite: Journalism 211 and 212, or equivalent.

326. Magazine Article Writing. Preparation of feature stories and articles; techniques of marketing, market analysis, and publishing articles written in the course. ½ unit. Prerequisite: Journalism 211 or consent of instructor. SCHACHT.

327. Special Topics in Twentieth-Century Journalism. Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. ½ unit. Prerequisite: Journalism 211 or consent of instructor.

329. **The Rhetoric of Journalism.** Studies in journalistic method, involving principally the analysis of structure and writing style as related to purpose. Materials are drawn from English and American journalism from the seventeenth century to the present, but emphasis is on work published in twentieth-century American newspapers and periodicals. ½ unit. Prerequisite: Journalism 211, or consent of instructor. SCHACHT.

330. **Magazine Editing.** Basic principles of editing for consumer, business, trade, and company magazines; communications theory, market analysis, editorial process, design process, production process, and distribution process as they relate to magazine publishing. ½ unit. Prerequisite: Credit or registration in Journalism 326. SCHACHT, STAFF.

341. **Newspaper Management.** Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circulation, and commercial printing departments; plant operation. ½ unit. Prerequisite: Credit or registration in Journalism 204.

344. **Community Newspaper Publication.** Study of weekly newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. ½ unit. Prerequisite: Journalism 212 or consent of instructor. GILMORE.

372. **Social Aspects of Mass Communications.** Same as Communications and Sociology 372. Media structures related to cultural content and functions. Problems of life and society as treated in mass-produced communications. ½ unit.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a Master of Arts degree in Labor and Industrial Relations. Students taking master's or doctoral degrees in other departments—economics, industrial administration, communications, history, political science, sociology, psychology, and others—may arrange a minor in labor and industrial relations.

Graduate instruction is offered in trade union and management organization, in the accommodation of these organizations through the process and structure of collective bargaining, in personnel administration and employee relations, in the role of government in legislating labor standards and labor relations, and in the formulation of public policy. These matters are studied in the context of social, economic, and political change, and are analyzed with the help of theoretical and empirical formulations of economics, history, law, political science, psychology, and sociology.

A student seeking admission to the Institute must meet the general entrance requirements of the Graduate College. In addition, the Institute reviews the undergraduate record of every candidate and may refuse admission to a student whose record indicates inadequate preparation. Prerequisites are a course in labor problems and a course in statistics. Students who cannot meet these course prerequisites may register for graduate work but must remove the deficiency during the first semester by taking the required course or courses without graduate credit. Course work in the various social sciences is desirable as preparation for the Institute program.

A candidate for a Master of Arts in Labor and Industrial Relations has a choice of study programs. Program A requires eight units of graduate credit including one unit of research seminar (Labor and Industrial Relations 493), a minimum of two units of thesis (Labor and Industrial Relations 499), five units of electives, and successful completion of an oral examination focused on the thesis.

Program B requires a total of ten units including one unit of research seminar

(Labor and Industrial Relations 493), one unit of readings (Labor and Industrial Relations 492), three units in three different academic disciplines (selected from economics, history, political science, psychology, or sociology), five units of electives, and successful completion of both oral and written comprehensive examinations focused on the course work. During his last semester at the Institute, a Program B student participates in a tutorial program during which he meets periodically with his tutor (a member of the faculty) and completes assigned essays or case studies on topics which will permit the use of concepts and methods of analysis of several disciplines.

Full details and further elaboration of the Institute programs and requirements are given in the bulletin, *Graduate Study for a Master of Arts Degree in Labor and Industrial Relations,* which may be obtained by writing to the Institute of Labor and Industrial Relations, Urbana 61803.

GRADUATE FACULTY

Professors: M. Wagner (Director of Institute of Labor and Industrial Relations), W. E. Chalmers, M. Derber, M. Edelman, P. L. Garman, J. R. Gusfield, B. Karsh, S. B. Levine, W. McPherson, A. F. Sturmthal.

Associate Professors: W. H. Franke, M. Rothbaum, H. C. Triandis.

Assistant Professors: C. L. Hulin, H. E. Trier.

COURSES FOR GRADUATES

418. Seminar in Industrial and Economic Sociology. Same as Sociology 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Labor and Industrial Relations 318 or consent of instructor. Karsh, Phillips.

420. Formation of Public Policy. Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. 1 unit. Hagan.

435. Motivation and Morale in Industry. Same as Psychology 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. Triandis.

440. Labor Economics. Same as Economics 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics. McNatt.

441. Labor Economics. Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics. McNatt.

442. Collective Bargaining. Same as Economics 442. The development of a theory of the continuing interactions between union and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the

structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. 1 unit. Prerequisite: Consent of instructor. CHALMERS.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling; analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

444. **Economics of Manpower Resources.** Same as Economics 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. PARRISH.

446. **Foreign and International Labor Movements.** History and organization, economic and political policies of the major labor movements in the world; their international organizations; comparative analysis of particular problems confronting these movements; labor movements in underdeveloped areas; labor and economic development; labor under totalitarian regimes. 1 unit. Prerequisite: Consent of instructor. STURMTHAL.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. GARMAN.

448. **Problems of Personnel Management.** Same as Industrial Administration 448. An examination of the organization and administration of the personnel function in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 248 or equivalent, or consent of instructor.

449. **Problems of Personnel Management.** Same as Industrial Administration 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Labor and Industrial Relations 448 or equivalent.

450. **Management and Industrial Relations.** An analysis of the industrial relations function in management. Using case problems, research reports, and theoretical analyses, an examination is made of the development of the industrial relations function, alternate organizational approaches in dealing with employees and unions, the formation of labor relations policies, and management responsibilities in industrial relations. 1 unit. Prerequisite: Consent of instructor.

490. **Individual Topics.** A student in labor and industrial relations may register for this unit with the consent of his curriculum adviser and the adviser under whom he will perform the individual study or research. Such individual

work may include special study in a subject matter for which no course is available or an individual research project, including on-the-job research in industry, which is not being undertaken for a thesis. 0 to 2 units. STAFF.

492. **Readings in Labor and Industrial Relations.** Readings and analysis of important works in the field of industrial relations. The course is designed to emphasize the differing but complementary approaches of several social sciences to industrial relations problems. The interdisciplinary approach is sought both through selection of readings and through the participation of various Institute staff members in discussions dealing with their special interests. 1 unit. Prerequisite: Consent of instructor. ROTHBAUM.

493. **Research Seminar in Labor and Industrial Relations.** Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, FRANKE.

494. **The Major Theorists of Industrial Relations.** An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. 1 unit. Prerequisite: Consent of instructor. DERBER.

496. **The Evolution of Labor-Management Relations in America.** Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. 1 unit. Prerequisite: Graduate standing in Labor and Industrial Relations or consent of instructor. DERBER.

498. **Analysis of Organizations in Industrial Relations.** An intensive analysis of organizational behavior, with the main focus upon the theory of organizations as social institutions. Concepts are drawn from the various social sciences and applied to the principal organizations concerned with industrial relations. The internal dynamics of unions, managements, and government agencies are examined, with special reference to decision-making processes, and are related to the interactions among them. 1 unit. Prerequisite: Consent of instructor. LEVINE.

499. **Thesis Research.** For all students writing theses in labor and industrial relations. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

312. **Human Relations in Business.** Same as Industrial Administration 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and between different economic and social groups. ½ or ¾ unit. Prerequisite: Industrial Administration 101 or equivalent. DAUTEN.

318. **Industry and Society.** Same as Sociology 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH, PHILLIPS.

342. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108. MCNATT.

344. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240. McNatt.

347. **Labor Law.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts. 1 unit.

355. **Industrial Social Psychology.** Same as Psychology 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid to understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or Labor and Industrial Relations 357. Triandis.

357. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. Hulin.

360. **Group Insurance and Pensions.** Same as Finance 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. ½ or 1 unit. Prerequisite: Economics 240, Finance 260, or Industrial Administration 248. Mehr.

365. **Government and Labor.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191. Edelman.

LATIN AMERICAN STUDIES

Graduate minors in Latin American Studies are administered by the Center for Latin American Studies Committee.

Candidates for the master's degree who elect a minor in Latin American Studies must complete two units from the courses listed below. Doctoral candidates who elect a minor in this area must complete four units for a sole minor, or two units for a split minor, from the following courses.

These elective courses must be taken in at least two departments and are described under the departmental listings: Agricultural Economics 401; Agronomy 429; Anthropology 350, 352, 361, 380, 490; Art 318, 491; Botany 300; Economics 328, 329, 352, 411, 490; Geography 332, 495; History 375, 376, 377, 476; Philosophy 319, 483; Political Science 342, 343, 441, 442, 493; Portugese 301, 303, 304, 305, 306, 491; Sociology 373, 490; Spanish 307, 308, 332, 431, 432, 433, 434, 435, 436, 437, 438.

Students in technical and professional colleges and schools of the University who seek knowledge of Latin American affairs, culture, and languages are invited to consult with the director of the Center for Latin American Studies, 1207 West Oregon Street, Urbana, or with their advisers, in order to develop programs suited to their individual needs. Such a program may often be adopted as a special minor under existing regulations if the student so desires. These courses are of particular value to students who intend to carry on technical or professional work in the Latin American area for the government, private business, publications, or religious organizations.

LAW

The College of Law offers a program of graduate work leading to the Master of Laws (LL.M.), Master of Comparative Law (M.C.L.), and Doctor of the Science of Law (J.S.D.).

A student whose undergraduate study in law has been in systems based on the Anglo-American common law is eligible to apply for candidacy for the Master of Laws or Doctor of the Science of Law. A foreign lawyer whose prior law study has been in a system which is not based on the Anglo-American common law may, in exceptional cases, be admitted to candidacy for the Master of Laws or Doctor of the Science of Law, or such foreign lawyer may apply for candidacy for the Master of Comparative Law. The Master of Comparative Law program is designed to develop facility in the comparative method and to prepare a foreign lawyer to deal knowledgeably with Anglo-American problems.

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws unless he has a grade-point average of 3.5 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of Science of Law is normally required to have a grade-point average of 4.0 in all law work previously undertaken. and also to present evidence that he has the ability to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Bachelor of Laws or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for an advanced degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the Master of Laws must secure an average of 3.5 in his graduate law courses; the candidate for the Doctor of the Science of Law, an average of 4.0.

Details of the programs may be obtained from the Dean of the College of Law, 209 Law Building.

GRADUATE FACULTY

Professors: R. N. Sullivan (Dean of College of Law), C. H. Bowman, K. S. Carlston, E. W. Cleary, R. G. Cohn, J. E. Cribbet, W. H. Davis, G. T. Frampton, E. F. Scoles, V. J. Stone, J. N. Young.

Associate Professor: P. H. Hay.

COURSES FOR GRADUATES

400. Seminar: Legal Education. Problems in legal education, curricula, teaching materials, methods of teaching, the place and function of individual courses in the law school program. ½ unit.

499. Thesis Research. ½ to 2 units.

PROFESSIONAL COURSES

301. Contracts A. Offer and acceptance, consideration, seals, Statute of Frauds. 1 unit (for recommended M.C.L. candidates only). Davis.

302. **Contracts B.** Third-party beneficiaries, assignment, conditions, impossibility, anticipatory repudiation, and discharge; contract and quasi-contract distinguished, and measure of damages for each. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 301. DAVIS.

303. **Torts A.** Basic course in civil wrongs, including intentional infliction of emotional harm, right of privacy, libel and slander, and unfair commercial practices. ½ unit (for recommended M.C.L. candidates only).

304. **Torts B.** Basic course in civil wrongs, including negligence, liability without fault, tort liability of owners and occupiers of land, and the impact of insurance on tort liability. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 303.

305. **Judicial Remedies.** Introduction to civil procedure, common-law forms of action, extraordinary legal remedies, nature of equity jurisprudence, equitable remedies, abolition of the forms of action, fusion of law and equity, statutory remedies. 1 unit (for recommended M.C.L. candidates only). STONE.

307. **Property A.** The concept of property; acquisition of private property; recognized property interests (personal, real, estates in land). 1 unit (for recommended M.C.L. candidates only). CRIBBET.

308. **Property B.** Gratuitous transfer of property interests; commercial transfers (sale, lease); the use of property. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 307. CRIBBET.

309. **Criminal Law.** The sources and purposes of the criminal law; the meaning of criminal responsibility; the characteristics of particular crimes. 1 unit (for recommended M.C.L. candidates only). BOWMAN.

310. **Constitutional Law.** The apportionment of governmental power between the United States and the states, and the limitations on power resulting from the contract, equal protection, and due process clauses. 1 unit (for recommended M.C.L. candidates only). SULLIVAN.

320. **Business Associations.** The fundamental legal consequences to principals, agents, and third parties of association in various types of business transactions and in various forms of business enterprise. 1 unit (for recommended M.C.L. candidates only). FRAMPTON.

322. **Commercial Law, I.** A study of the major problems involved in modern commerce, the legal and nonlegal tools that are available for solving these problems, and the traditional solutions which have been hammered out. Particular emphasis upon the law of sales, negotiable instruments, banks and banking, letters of credit, bulk sales and fraudulent conveyances, documents of title, and security transactions. 1 unit.

323. **Administrative Law.** The functions of administrative tribunals in federal, state, and municipal government, the procedure before such administrative tribunals, and judicial relief from administrative decisions. 1 unit. COHN.

324. **Corporations.** Promotion and organization of corporations and the rights and liabilities of officers, directors, and shareholders. 1 unit. FRAMPTON.

325. **Pleading.** Obtaining information and forming issues in advance of trial. 1 unit. CLEARY.

326. **Evidence.** Principles governing the competency of witnesses and the admissibility of evidence. 1 unit. CLEARY.

328. **Income Taxation.** A study of federal income tax problems relating to business and investment transactions. Subjects treated include the concept of taxable income; allowable deductions; accounting for income and deductions; capital gains; partnership operations; corporate distributions and reorganizations; and tax procedure. 1 unit. YOUNG.

329. **Decedents' Estates and Trusts.** A study of the gratuitous disposition of property by intestacy, by will, and by inter vivos gifts and trusts, including administration of decedents' estates and trusts. 1 unit. SCOLES.

330. **Restitution.** Contractual and quasi-contractual remedies (both legal and equitable) available because of duress, fraud, innocent misrepresentation, mistake, illegality, and economic compulsion in the formation and discharge of contracts and other transactions. 1 unit. DAVIS.

331. **Legislation.** A study of legislative policies and procedures, of legislation as a source of law, of types of statutes and their structure, and of the problems of interpretation. 1 unit. COHN.

333. **Persons.** Creation and dissolution of the family unit and relations between members thereof; marriage, separation, divorce, rights and duties of spouses and means for their enforcement; legal capacity of wife and infant. ½ unit. CARLSTON.

334. **Criminal Law Administration and Procedure.** Problems in the administration of the criminal law; a study of criminal procedure from arrest to the end of the prosecution in a court of review, with emphasis on procedure as a device for social regulation, and including an appraisal of aims and workings of probation, parole, and executive clemency. ½ unit. BOWMAN.

335. **Trials and Appeals.** Litigation from process through appeal, excluding pleading and evidence. 1 unit. STONE.

337. **Commercial Law, II.** Selected problems in modern commercial law and practice. ½ unit.

338. **Insurance.** Personal and property insurance; formation of the insurance relation; concealment, warranties, representations; insurable interests; conditions; subrogation; waiver and estoppel; incontestability; the respective interests of the beneficiary, insured, insurer, assignee, and creditor, and facts constituting maturity in life, accident, fire, theft, liability, and collision policies. 1 unit. DAVIS.

339. **Conflict of Laws.** Problems from conflict of laws in jurisdiction of courts; foreign judgments; torts and workmen's compensation acts; contracts; sales and mortgages; family law; administration of estates; business organizations. 1 unit. SCOLES.

340. **Municipal Corporations.** Creation and organization; powers; city planning and zoning liability on contracts and in tort; property rights; revenue and indebtedness. ½ unit.

341. **Oil and Gas.** Nature of the property interests in oil and gas; legal interests created by oil and gas leases; validity of leases; the habendum clause; the drilling and rental clauses; transfer of oil and gas interests; rents and royalties; public regulation of the production of oil and gas. 1 unit.

342. **Mortgages.** A study of real estate mortgages. 1 unit.

343. **Admiralty.** Admiralty and maritime jurisdiction; the maritime lien; carriage of goods; salvage; general average; collision; claims of seamen; limitation of liability; application of state law; sovereign responsibility; choice of law. 1 unit. DAVIS.

344. **Creditors' Rights.** Remedies of the delinquent debtor and his creditors under the Bankruptcy Act; liquidation and rehabilitation; exercises in bankruptcy procedures. 1 unit. BOWMAN.

346. **Future Interests.** A study of the validity and effect of gratuitous dispositions of assets in which enjoyment is postponed, restrained, or long continued; classification of future interests; construction; powers of appointment; rule against perpetuities and related restrictions. 1 unit. SCOLES.

347. **Labor Law.** Same as Labor and Industrial Relations 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts. 1 unit.

348. **International Law.** The nature, sources, and subjects of international law, its place in the control of international society, and an examination of the law of jurisdiction, territory, recognition, and succession of states, rights and immunities of states in foreign courts, diplomatic immunities, treaties, protection of citizens abroad, settlement of international disputes, war and neutrality, the United Nations, and the International Court of Justice. 1 unit. CARLSTON.

349. **State and Local Taxation.** Proper and improper purposes of taxation; the general property tax and its administration; taxpayers' remedies; excise taxes on business concerns and transactions; problems of jurisdiction to tax. ½ unit. YOUNG.

351. **Jurisprudence.** The place of law in society, the goals and methods of law, the nature of law, relation of law and social science. 1 unit. CARLSTON.

352. **Taxation of Gratuitous Transfers.** Various tax problems encountered in the distribution of wealth by inter vivos and testamentary disposition, including a study of federal estate and gift taxes, the Illinois inheritance tax, problems in the assignment of income, and federal income taxes upon estates and trusts. Attention is given to tax planning in the distribution of wealth. ½ unit. YOUNG.

353. **Corporation Finance and Securities.** Drafting provisions of preferred shares; counseling problems requiring written memoranda on the application of state and federal securities laws to the marketing of securities and on the effect of statutes and decisions on distribution of dividends, redemption and purchase of shares, and recapitalization, reorganization, and dissolution of corporations. ½ unit. FRAMPTON.

355. **Trade Regulation.** Antitrust law, control of restrictive business practices. monopoly, unfair competition, trademarks, price discrimination, resale price maintenance, Federal Trade Commission. 1 unit. CARLSTON.

356. **Federal Courts.** The federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state tribunals. 1 unit. STONE.

358. **Social Legislation and the Employee.** Analysis of the legal protection furnished individual employees through workmen's compensation, unemployment compensation, social security, fair labor standards, and similar legislation. 1 unit.

359. **Legal History.** The development of the common-law system in England and America: the origin and growth of English legal thought, legal doctrine, and legal institutions; the history of real property, contracts, and torts; the origin and development of courts, legislation, equity, the doctrine of precedent; the evolution of the legal profession; the reception of the common law in America. 1 unit.

369. **Soviet Law.** An examination of Soviet conceptions of the role of law as evidenced both in theory and in practice; emphasis on highlights of Soviet law, with comparison to the common law and civil law traditions; study of Soviet court and legislative materials to determine characteristic pattern with respect to: constitution and administration, the relation of the individual with the state and with society; legal regulation of property and productive institutions, private relationships, and international law. 1 unit.

371. **Seminar in Selected Legal Problems.** An introduction to the methods and materials of legal research. The work of the course consists of the discussion of selected topics. In addition, each student investigates a topic approved by the instructor. The results of the investigation are presented orally to the

class and submitted in writing to the instructor. The several sections are oriented to different subject matter areas. Credit may be earned in more than one section. ½ unit.

382. Comparative Law. A comparative analysis of the three basic institutions of private law: tort, contract, and property. The solutions arrived at in the common-law system are contrasted with the solutions arrived at in the civil law system and in the Soviet legal system. 1 unit.

383. Law and Society. An examination of some important ideas concerning the nature of law and the role of law in society. 1 unit.

387. International Economic Organizations. A survey of the principal international economic organizations such as GATT, OECD, ECE, and international monetary and investment institutions (IMF, IBRD, AID); an intensive study of the European Common Market, particularly of its laws relating to trade barriers, establishment of companies, and antitrust; United States legislation in the field of international trade (Trade Expansion Act of 1962). 1 unit.

399. Research in Special Topics. Individual research on a special problem selected in consultation with the instructor. ½ or 1 unit.

LIBRARY SCIENCE

The purpose of the Graduate School of Library Science is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree, certificate of advanced study in librarianship, and the doctor's degree in library science.

Master of Science. Applicants for admission to the Graduate School of Library Science must first be admitted to the Graduate College.

In addition to the Graduate College requirements, applicants to the Graduate School of Library Science must meet the following requirements: (1) A minimum grade-point average of 3.75 for the last sixty hours of academic work completed. (2) One sequence (two semesters) of courses at the college level in each of the three main fields of science, social science, and humanities, and a total of four such sequences in all. (3) A major subject in any field of study, comparable to the undergraduate major at the University of Illinois (twenty semester hours). (4) Two years of college-level study of any foreign languages. This may be either two years of study of one language or one year of each of two languages.

A candidate for the master's degree must complete a prescribed program of undergraduate courses. This requirement may be met by one of the following: (1) Completion of a minimum of sixteen semester hours of library science with a grade-point average of at least 4.0 in an institution approved by the Graduate School of Library Science. (2) Completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, in the Graduate School of Library Science with a grade-point average of at least 3.75. Exemption from one or more of these courses may be secured by a satisfactory score on a comprehensive examination which is offered on the day preceding the opening of registration each semester and summer session. There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence before taking regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

At least two semesters in residence—or the equivalent—are required to earn the master's degree, in addition to attendance in preparatory courses. In this period, eight units of graduate study should be completed. Each student's program of study, adapted to his particular needs and purposes, is planned in consultation with an adviser at the time of original registration and thereafter. Students who

have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to complete Library Science 405, 407, and 411 or 412, and one of the 300-level literature courses. No thesis is required, but to insure that every candidate for a master's degree will have satisfactorily demonstrated his ability to assemble, organize, and present information and ideas in acceptable written form, the Graduate School of Library Science requires each student to prepare a formal term paper, designated as the master's project in one of his library science courses.

Students interested in the Advanced Master's program, the Certificate of Advanced Study in Librarianship, and the Doctor of Philosophy degree should write to the Director, Graduate School of Library Science, 329 Library, Urbana 61803.

GRADUATE FACULTY

Professors: R. B. Downs (Dean of Library Administration), H. Goldhor (Director of Graduate School of Library Science), H. Goldstein, Frances B. Jenkins, R. F. Stevens.

Associate Professors: Winifred C. Ladley, M. Alice Lohrer.

Assistant Professor: Cora E. Thomassen.

COURSES FOR GRADUATES

402. **Studies in Reading.** Designed to acquaint students with the major areas of investigation and interest in reading. Special attention is given to studies of reading interests and habits of children, youth, and adults. Class discussions are devoted to analysis of various studies and their implications for library service and classroom teaching. 1 unit. Ladley, Lohrer.

403. **Methods of Investigation in Librarianship.** Survey of library literature, with attention to examples of research in the library field, to elementary statistical procedures, and to the methods of investigation applicable to librarianship. Designed to prepare consumers rather than producers of research results. 1 unit. Jenkins.

405. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. 1 unit. Goldstein.

406. **Library Service to Children and Young Adults.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young adults in the public library. 1 unit. Prerequisite: Library Science 204 or 405. Ladley, Lohrer.

407. **Cataloging and Classification, I.** The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and the Library of Congress subject headings. 1 unit.

408. **Cataloging and Classification, II.** The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. 1 unit. Prerequisite: Library Science 407.

409. **Communication Roles and Responsibilities of Libraries.** Mass media of communication are considered in terms of their relations with modern library services; media organization, content, and research are reviewed; problems

of intellectual freedom are considered as an aspect of communications behavior; and the potential role of electronic devices in library activities now and for the future is discussed. 1 unit. GOLDSTEIN.

410. **Adult Education and Libraries.** The literature, history, and problems of adult education in the United States are presented in relation to the role of the library as an educational agency. Students study organization for adult education in the community and become familiar with the significant methods and materials used in a variety of educational programs. 1 unit. GOLDSTEIN.

411. **Reference Service in the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in some ten subject fields, with training and practice in their use for solving questions arising in reference service. 1 unit. STEVENS.

412. **Reference Service in Science and Technology.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. 1 unit. JENKINS.

424. **Government Publications.** The nature and scope of American and British government publications; the problems of organizations arising from their form and from the methods of their production and distribution. 1 unit. Prerequisite: Library Science 411 or 412, or consent of instructor.

427. **Resources of American Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; spatial and financial aspects of library resources; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; and ways and means of developing research collections in special subject fields. 1 unit. STEVENS.

428. **Physical Problems of Libraries.** A study of the library's physical plant in the light of changing concepts and patterns of library service. Present-day library buildings, both new and remodeled, are analyzed and compared with each other as well as with buildings of the past. The interrelationship of staff, collections, users, and physical plant is examined in detail. Class discussion is supplemented by visits to new libraries and conferences with their staffs. 1 unit. Prerequisite: Library Science 405 or consent of instructor.

429. **Information Storage and Retrieval.** Analyzes the problems which confront libraries and library users as a result of the growth of literature; reviews the various main solutions for storing and retrieving bibliographic information, such as traditional records and devices, coordinate indexing, edge-punched cards, machine-punched cards, and computers; emphasizes the practical applications of these devices in libraries. 1 unit. Prerequisite: Library Science 405; consent of instructor. JENKINS.

430. **Advanced Reference.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. 1 unit. Prerequisite: Library Science 424 or consent of instructor. STEVENS.

431. **History of Libraries.** The development of libraries from those of Nineveh to the present day. Includes the Hellenic libraries, Roman libraries, monastery libraries of the Middle Ages; the work of the great book collectors in building up collections which were turned over to national libraries; the development of the great private, academic, and tax-supported libraries which survive today. ½ or 1 unit. STEVENS.

432. **History of Books and Printing.** Same as Communications 432. The origin and evolution of the alphabet and of scripts; the history of manuscript books;

the invention and spread of printing; the account of the production and distribution of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. 1 unit. STEVENS.

433. **Advanced Subject Bibliography.** A study of the literature, information sources, and reference aids in various specialized fields of knowledge, identified as different sections of this course, from the point of view of their use by librarians. No student may take more than two different sections for credit toward a degree: (a) architecture, (b) biology, (c) chemistry, (d) education and psychology, (e) engineering, (f) journalism and communications, (g) law, (h) maps, (i) music. ½ unit. Prerequisite: consent of instructor. STAFF.

434. **Larger Units of Library Organization.** After a brief look at the "larger units" concept as manifested in other types of libraries, attention throughout the major portion of the course is centered on the public library. Library standards, the growth and development of county and regional libraries, the role of the state library, and the Library Services Act are among the topics treated in detail. Emphasis is on the theory, concept, and legal aspects, rather than on the operational detail, of larger units. 1 unit. Prerequisite: Library Science 405 or consent of instructor. GOLDSTEIN.

436. **Development of the Library Catalog.** The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor.

439. **Medical Literature and Reference Work.** Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources. 1 unit. Prerequisite: Consent of instructor.

441. **History of Children's Literature.** Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. 1 unit. LOHRER.

443. **Contemporary Book Publishing.** Survey of twentieth-century book publishing, particularly in America, placing it in an economic, social, and literary context. Emphasis is on production, technological developments, economic structure, methods of distribution and promotion, and book publishing as an art. 1 unit. BLUM.

COURSES FOR ADVANCED GRADUATES

450. **Advanced Studies in Librarianship.** Directed and supervised investigation of selected problems in library resources, reference service, research libraries, reading, public libraries, or school libraries. ½ to 2 units. Prerequisite: Fifth-year degree in library science; consent of director. STAFF.

461. **Descriptive Bibliography.** An introduction to descriptive bibliography, its methods, ideals, and purposes from the time of Bradshaw and Proctor to Greg and Bowers. Not a course in descriptive cataloging. 1 unit. Prerequisite: Open to advanced students from the Graduate School of Library Science and other departments of the University with consent of instructor.

462. **Education for Librarianship.** A study of the development of library education in this country and abroad. Not a course in teaching methods, but designed to provide understanding of the philosophical foundations of the several training agencies through analysis of their methods, content, character of personnel, and relationship to the profession at various times. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. GOLDSTEIN.

463. **Current Developments in Technical Services.** An examination of changing policies and procedures in the administration of cataloging, classification, and related areas. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STEVENS.

465. **Librarianship and Society.** Emphasis is upon the place of libraries as instruments of social thought and action in the twentieth century, as compared with the place and purpose of the library in the societies of the past. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. GOLDSTEIN.

469. **Principles of Research Methods.** Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. 1 unit. Prerequisite: Knowledge of the principles of statistics, Master of Science in Library Science or consent of instructor. GOLDHOR.

499. **Thesis Research.** Individual study and research. Section A: M.S. candidates, 0 to 2 units. Section B: Ph.D. candidates, 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Literature of the Humanities and Social Sciences.** This course is designed to build a knowledge of the scope and significant characteristics of the several fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. 1 unit. STEVENS.

302. **Literature of Science and Technology.** An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. 1 unit. JENKINS.

303. **Library Materials for Children.** The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, social, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. ½ or 1 unit. LADLEY, LOHRER, THOMASSEN.

304. **Library Methods for Young Adults.** The selection and use of library materials for the young adult in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. ½ or 1 unit. LADLEY, LOHRER, THOMASSEN.

308. **Audio-Visual Services in Libraries.** Designed to acquaint students with the typical audio-visual programs and responsibilities of libraries. Group activities comprise the practice work which illustrates the use of materials and equipment necessary for film, audio, radio, television, and exhibit needs. The organization and operation of audio-visual departments in libraries is stressed. 1 unit. THOMASSEN.

309. **Storytelling.** Fundamental principles of the art of storytelling including techniques of adaptation and presentation for children of various ages. Content and sources of materials; story cycles; methods of learning practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and for television. Open to undergraduates and non-Graduate School of Library Science students. ½ or 1 unit. LADLEY.

LIFE SCIENCES

The School of Life Sciences is a unit of the College of Liberal Arts and Sciences and includes the Departments of Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology. Study programs leading to the graduate degrees of Master of Science and Doctor of Philosophy exist in each of the departments and are described in detail in the following pages. Interdepartmental study programs leading to advanced degrees in cell biology and virology, and developmental biology, are administered within the School. The School also participates with other departments of the University in offering the Ph.D. program in genetics (see page 171) and with the Department of Chemistry and Chemical Engineering in offering a program in biophysical chemistry (see page 88). Applicants who desire to enter any of the graduate study programs are usually required to have earned a grade-point average of at least 4.0 for their last sixty hours of undergraduate work. In certain programs, applicants with a grade-point average between 3.5 and 4.0 will be considered by a special committee.

Support for graduate training is available in the form of teaching or research assistantships, University fellowships, or trainee fellowships. Prospective students may obtain application forms and relevant information for departmental study programs fom the executive officer of the appropriate department, or for interdepartmental study programs from the Director of the School of Life Sciences.

INTERDEPARTMENTAL STUDY PROGRAMS

Master of Science in the Teaching of the Biological Sciences and General Science. This degree is offered with the completion of the fifth year in the teacher-education curriculum in biological and general science. The degree is primarily intended for but not restricted to certified teachers of biology and general science in junior high school, high school, and junior college. For admission to this degree program, students must have a grade-point average of at least 3.5.

Candidates for the Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. Electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry is strongly advised. The adviser for candidates for this degree is Professor Wilson N. Stewart, 154b Natural History Building.

Master of Science in Biology. A program of study leading to the master's degree in biology is designed for individuals who (1) wish additional training at the master's level for professional proficiency in teaching or research, (2) desire to continue to the Ph.D. degree, possibly in one of the programs sponsored by the School of Life Sciences, or (3) do not wish to limit their training to a single area of biology.

Applications from individuals with grade-point averages between 3.5 and 4.0 must be accompanied by a three-hundred word essay by the applicant outlining his educational objectives.

Although no specific undergraduate courses are required for admission to this

curriculum, a year of physics and a course in organic chemistry must be completed before a degree is granted.

Candidates for the degree are advised to obtain a broad, basic training in biology and are examined in aspects of cellular, organismic, and population biology. Of the eight units required for the degree, at least one unit must be taken in 400-level courses. A thesis is not required, but at least one course must be included in which individual problems are assigned. A comprehensive examination is required of all candidates for the degree.

Students who are preparing themselves for high school teaching and who are not yet certified must fulfill state certification requirements.

Doctor of Philosophy in Biology. The School of Life Sciences offers Ph.D. programs in two specified interdepartmental areas, cell biology and virology, and developmental biology. Entrance requirements, in addition to those listed above for the M.S. program, include background training in general biology, physics, biochemistry, and calculus, but deficiences in these areas may be remedied during the first year of graduate study. Study programs are designed to suit individual needs in consultation with advisers. Descriptions of the area programs are given below.

Students who have been accepted for one of these programs may select any faculty member in the School of Life Sciences, or an appropriate member of the Biochemistry Division as a major adviser. Additional information may be obtained from the Director of the School of Life Sciences.

CELL BIOLOGY AND VIROLOGY

The cell biology and virology program emphasizes molecular mechanisms and is therefore addressed to students who have acquired or wish to acquire a strong background in chemistry. Areas of research open to students in this program include cytochemistry, biochemistry of subcellular systems, cellular differentiation, intracellular regulation of meiosis and mitosis, circadian rhythms, cellular genetics, and virology.

DEVELOPMENTAL BIOLOGY

The developmental biology program emphasizes the study of developmental processes in cells, tissues, and organ systems. Training in the techniques of cytochemistry, histochemistry, cell fractionation, electron microscopy, microspectrophotometry, microelectrophoresis, immunology, tissue culture, and transplantation of tissues and organs are provided as required.

In addition to the entrance requirements, students are required to complete courses in embryology, cytology-histology, and genetics.

Biology

The following courses are administered directly by the School of Life Sciences. These courses, as is the case with departmental courses, are applicable to the study programs within the School.

COURSES FOR GRADUATES

423. Electron Microscopy. Same as Chemistry and Zoology 423. Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Open to qualified graduate students in all departments. ¼ unit. Prerequisite: Background in chemistry, physics, and mathematics; consent of instructor. HALL.

429. **Electron Microscopy Laboratory.** Same as Chemistry and Zoology 429. Essentially individual instruction. Detailed training in operation and care of electron microscopes (four types); preparation of specimens including microtomy, electron staining, replication, and shadow casting; measurements and interpretations; special projects related to student's research interests. ½ or ¾ unit. Prerequisite: Graduate major in a biological science with adequate background in chemistry, physics, and mathematics; credit or registration in Biology 423; consent of instructor. HALL, PAGE.

490. **Special Topics in Biology.** Individual topics in research and/or reading conducted under the supervision of faculty members in the School of Life Sciences. This course is particularly designed for students enrolled in the biology program who would like to become more familiar with specialized fields of study prior to committing themselves to a specific area for their doctorate degree. 0 to 1 unit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. **Population Biology.** A study of problems associated with the behavior of plant and animal populations based on genetic, evolutionary, and ecological principles. ¾ unit. Prerequisite: Biology 151 and 251, and/or consent of instructor. GHENT.

DEPARTMENTAL STUDY PROGRAMS AND COURSES

Botany

The Department of Botany offers graduate work leading to the Master of Science and Doctor of Philosophy. Candidates for advanced degrees must have had at least twenty hours of undergraduate work in botany, or fifteen hours in botany and five hours in a related subject acceptable to the department. The applicant's grade-point average must be at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The following subjects comprise a partial listing of the areas of specialization available in the department: cytology, cytogenetics, anatomy, morphology, morphogenesis, paleobotany, ecology, plant geography, taxonomy, cytotaxonomy, physiology (including photosynthesis), physiological genetics, mycology, phycology, virology, and ultrastructure.

Courses offered in the Departments of Agronomy, Chemistry and Chemical Engineering, Entomology, Geography, Geology, Horticulture, Mathematics, Microbiology, Physics, Physiology and Biophysics, Plant Pathology, and Zoology are available to advanced students and offer a broad foundation for botanical work. Graduate students in botany may elect their minor subjects in one or two of these fields.

Special Facilities. Graduate students may avail themselves of the University herbarium which contains 500,000 specimens of vascular plants, bryophytes, algae, fungi, and fossil plants. As field laboratories, the University maintains two tracts of woodland, Brownfield Woods and Trelease Woods; in addition, certain areas of Robert Allerton Park near Monticello have been designated for research and study. Greenhouses, garden plots, and growth chambers are maintained for experimental work with living plants. Well equipped laboratories are available for each area of specialization within the department. The Maize Genetics Research Laboratory maintains an extensive collection of maize genetic stocks adapted to the North Central states; the College of Agriculture and the Agricultural Experiment Station

offer exceptional facilities to graduate students in plant genetics, plant pathology, and in some of the other plant sciences. The Biology Library, with over 70,000 volumes, offers excellent library facilities, with bibliographical aids including the Gray Herbarium Card Index of American Plants, the Index of American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis.

Departmental Qualifying Examination. A written qualifying examination must be taken by all new graduate students majoring in botany at the beginning of their first semester regardless of whether they have done work beyond the bachelor's degree. This examination will be offered in the week prior to the opening of the first or fall semester and in the week prior to the opening of the second or spring semester. The examination will be used to determine the level of information in the following areas: (1) ecology, (2) genetics, (3) morphology, (4) physiology, and (5) taxonomy. The results of the examination are used by the departmental qualifying examination committee and the student's adviser to recommend future graduate courses, and no permanent record is made of the results.

Students with deficient preparation in any one of the five areas can remove the deficiency: (1) by passing an examination in the deficient areas or substitute areas after a period of independent reading and study; (2) by registration in a course in the field of deficiency and by passing the course with a grade of B or better; (3) by substitution of courses in botany, approved by the qualifying examination committee and the adviser. A limit of two substitutions is allowed for each student.

Master of Science. During their graduate or advanced undergraduate work, candidates for this degree must have completed courses in the following basic fields of botany: (1) taxonomy (Botany 460 or equivalent), (2)) morphology (Botany 302 and 303, or equivalent), (3) ecology or plant geography (Botany 381 or equivalent, (4) genetics (Botany 210 or equivalent), (5) physiology (Botany 330 or equivalent).

A thesis is not required of candidates for the Master of Science except at the option of the graduate student's major adviser. Graduate students do not receive credit toward the master's degree in Botany 499 unless they write acceptable master's theses. A student may engage in graduate work toward the Doctor of Philosophy without having obtained a master's degree.

Doctor of Philosophy. Candidates for this degree must complete the course requirements listed above before receiving the Doctor of Philosophy. Having satisfied these basic course requirements imposed by the qualifying examination, the candidate for the doctor's degree may elect whatever other graduate courses he desires, subject to the approval of his major adviser and to the general regulations of the Graduate College concerning requirements in his major and minor fields (see pages 23 to 25).

Opportunities for biophysical research also are available in the Department of Botany in an interdepartmental curriculum leading to the Doctor of Philosophy in Biophysics, and requiring a combined training in physics, chemistry, and biology (see page 228).

GRADUATE FACULTY

Professors: J. R. Laughnan (Head of Department), L. M. Black, H. J. Fuller, J. B. Hanson, G. N. Jones, E. I. Rabinowitch, M. E. Reichmann, D. P. Rogers, D. M. Steffensen, W. N. Stewart.

Associate Professors: L. C. Bliss, Z. B. Carothers, J. F. Nance.

Assistant Professors: Govindjee, L. R. Hoffman, D. Paolillo, Jr., W. W. Payne.

COURSES FOR GRADUATES

402. **Molecular Genetics.** See Zoology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. ATWOOD, SPIEGELMAN, WOESE.

403. **Physiology of Fungi.** Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activitiy is discussed. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Organic chemistry or biochemistry; mycology, plant pathology, or microbiology. GOTTLIEB.

405. **Microbiological Genetics.** See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. ATWOOD, NANNEY, SPIEGELMAN.

410. **Botany Discussions.** All graduate students in botany, except those with conflicting teaching assignments, are required to register in and attend the general seminar. No credit is given except to those students presenting the results of their Ph.D. thesis research. 0 or ¼ unit. GOVINDJEE.

411. **Discussions in Genetics and Cytogenetics.** Same as Zoology 411. ¼ unit. KITZMILLER, LAUGHNAN, NANNEY, STEFFENSEN.

413. **Discussions in Plant Physiology.** ¼ unit. NANCE.

414. **Discussions in Plant Morphology and Taxonomy.** ¼ unit. NANCE.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. ¼ unit. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. BLISS.

419. **Discussions in Photosynthesis and Related Topics.** ¼ unit. Prerequisite: Consent of instructor. GOVINDJEE, RABINOWITCH.

421. **Cytogenetics.** Same as Zoology 421. Chromosome Theory: the structure, behavior, and physiology of chromosomes in heredity and development. 1 unit. Prerequisite: Botany 210, or Microbiology 330, or consent of instructor. STEFFENSEN.

424. **Mineral Nutrition of Plants.** Same as Agronomy and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

427. **Discussions in Mycology.** A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. ¼ unit. Prerequisite: Consent of instructor. ROGERS.

428. **Palynology.** Same as Geology 428. The study of pollen and other spores, with emphasis on their evolution, paleoecological significance, stratigraphic application, and methods of preparation for study. ½ or 1 unit. Prerequisite: Botany 120 or Geology 101 or consent of instructor.

431. **Laboratory in Cytological and Cellular Techniques.** Same as Zoology 431. A laboratory-discussion course on modern methods in cytological and cytochemical techniques including special studies on nuclear and cell division. ½ unit. Prerequisite: Registration in Botany 420; consent of instructor. STEFFENSEN.

433. **Advanced Physiology of Growth, Responses, and Reproduction.** 1 unit. Prerequisite: Botany 330 or equivalent. HANSON, MCCOLLUM, NANCE, WILSON.

436. **Principles in Plant Physiology.** A laboratory course illustrated by experiments with algae and including experiments on the nutrition of algae, photosynthesis, respiration, and enzyme processes; special emphasis is on photosynthesis. Enrollment limited to six students. 1 unit. Prerequisite: At least one course at the college level in each of the following: biology, chemistry, and physics (or physical chemistry). GOVINDJEE.

450. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. ½ or 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. HOFFMAN.

451. **Advanced Cellular Physiology.** See Physiology 451. ½ unit. Prerequisite: Consent of instructor. STAFF.

460. **Advanced Taxonomy of Flowering Plants, I.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Botany 160 or one year of botany or another biological science, or consent of instructor. JONES.

461. **Advanced Taxonomy of Flowering Plants, II.** The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. ½ or 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Botany 160 and 210 or equivalent; consent of instructor. PAYNE.

471. **Advanced Mycology: Special Groups.** The several classes of fungi and their activities are considered in successive semesters. Special groups within these classes may be selected for concentrated study, depending upon the student's interest in mycology. ½ unit. Prerequisite: Botany 372 or consent of instructor. ROGERS.

493. **Advanced Studies in Botany.** ½ to 2 units. Not more than one unit may be applied toward the Graduate College master's degree requirement of 3 units of course work at the 400 level. Work may be taken in the following fields:

(a) **Anatomy.** CAROTHERS, PAOLILLO.
(b) **Bryology.** JONES.
(c) **Cytogenetics.** STEFFENSEN.
(d) **Cytology.** STEFFENSEN.
(e) **Ecology.** BLISS.
(f) **Genetics.** LAUGHNAN.
(g) **Morphogenesis.** PAOLILLO.
(h) **Morphology.** CAROTHERS, PHILLIPS, STEWART.
(i) **Mycology.** ROGERS.
(j) **Paleobotany.** PHILLIPS, STEWART.
(k) **Photosynthesis.** GOVINDJEE, RABINOWITCH.
(l) **Phycology.** HOFFMAN.
(m) **Physiology.** HANSON, NANCE.
(n) **Taxonomy.** JONES, PAYNE.
(o) **Ultrastructure.** CAROTHERS, HOFFMAN, PAOLILLO.
(p) **Virology.** BLACK, REICHMANN.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degeee. ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. STAFF.

301. **Plant Pathology.** Same as Plant Pathology 301. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

302. **Comparative Morphology: Nonvascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, and bryophytes. Students receiving credit for Botany 302 do not receive credit for Botany 304. ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. HOFFMAN, ROGERS.

303. **Comparative Morphology: Vascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative vascular plants, including psilopsids, lycopsids, sphenopsids, ferns, gymnosperms, and angiosperms. Students receiving credit for Botany 303 do not receive credit for Botany 304. ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. PHILLIPS.

304. **General Plant Morphology.** A survey of the principles of plant morphology as exemplified by the various plant groups. Modification of course is made to meet the needs of teachers and prospective teachers. Students receiving credit for Botany 304 do not receive credit for Botany 302 or 303. S; ½ or 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent; consent of instructor. STAFF.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. This course adjusted to professional semester (practice teaching) for students in teacher-training curriculum. Two four-hour field trips to be given on Saturday. ½ unit. Prerequisite: Botany 100 and Zoology 101 or 104, or a one-year course in general biology; expectation of teaching. STAFF.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. ALGER, SILVERMAN.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307 and consent of instructor. ALGER, SILVERMAN.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. STEWART.

330. **Intermediate Plant Physiology.** A lecture and laboratory course dealing with the principles of plant physiology at an intermediate level. For students majoring in botany and others primarily interested in the plant sciences. 1 unit. Prerequisite: One year of biology and one semester of organic chemistry. NANCE.

340. **Histological Technique.** Survey of techniques used in the preparation of plant tissues for microscopical examination. 1 unit. Prerequisite: One year of botany or ten hours of zoology, and consent of instructor. PAOLILLO.

341. **Field Ecology.** Study of plant communities in various sections of North America during spring vacation (trips rotate on a three-to-five-year basis); outdoor cooking and camping; transportation in University cars. ¼ unit; may be repeated for a maximum of ¾ unit. Prerequisite: One of the following—Botany 160, 366, 381, 385; consent of instructor. BLISS.

345. **Plant Anatomy.** Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. 1 unit. Prerequisite: One year of botany. CAROTHERS.

366. **Field Botany.** Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. JONES.

372. **General Mycology.** Stucture, classification, and identification of fungi, including those of economic importance. 1 unit. Prerequisite: One year of botany, entomology, microbiology, or zoology. ROGERS.

381. **Plant Ecology.** Principles of ecology, exemplified by vegetation and environments of Illinois. 1 unit. Prerequisite: Botany 160 or equivalent. BLISS.

382. **Ecological Methods.** Field methods used in plant ecology. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: One year of botany including Botany 381 or equivalent. BLISS.

385. **Plant Geography of North America.** Vegetation regions and principal subdivisions; environments, plant cover, floras. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Botany 381 or equivalent, one course in geology is also recommended. BLISS.

Entomology

The Department of Entomology offers graduate work leading to the Master of Science and Doctor of Philosophy. Admission requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology gain a thorough grounding in the fundamentals of physical and biological science, mathematics, and the liberal arts.

Candidates for the Master of Science in Entomology are required to earn two units in a basic sequence that includes the fundamentals of insect morphology, physiology, and taxonomy, plus one unit each in more advanced courses in insect morphology, physiology, and control. Electives make up the balance of the eight-unit requirement. Not more than two units of research credit may be elected, and if research credit is presented, a thesis is required. The candidate must pass an oral examination covering the general field of entomology.

Candidates for the Doctor of Philosophy in Entomology must satisfy the department course requirements for the master's degree and must also earn one unit of credit in insect bionomics and one unit in insect taxonomy. The remainder of their program is made up of electives.

The chief fields of specialization in the department are: general entomology (including morphology and taxonomy), insect bionomics, applied entomology (including economic entomology and medical entomology), toxicology of insecticides, and insect physiology. The department is well equipped to offer work in these areas, and the facilities of the State Natural History Survey are also available for advanced study. Outstanding entomological library facilities are located on the campus.

The requirements of the department in regard to minors are the following: For a sole minor, four units must be taken outside the depatment in one of the following areas: agronomy, botany (including plant pathology), chemistry, horticulture, microbiology, physiology, and zoology. A first minor (two units) may be taken in a field of specialization in entomology other than the major, and the second minor (two units) must be in a related subject outside the department. For minors outside the Department of Entomology, the candidate should in all cases check the requirements both with his adviser and with the department concerned.

GRADUATE FACULTY

Professors: C. W. KEARNS (Head of Department), L. E. CHADWICK, G. FRAENKEL, W. R. HORSFALL, H. H. ROSS, J. G. STERNBURG.

Associate Professors: S. Friedman, E. R. Jaycox, R. B. Selander.
Assistant Professors: A. W. Ghent, J. R. Larsen, G. P. Waldbauer.

COURSES FOR GRADUATES

410. **Insect Morphology.** A comprehensive study of the internal and external structure of insects, from the comparative viewpoint. 1 unit. Prerequisite: Entomology 301. Chadwick, Sternburg.

413. **Medical and Veterinary Entomology.** Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. 1 unit. Prerequisite: Entomology 101, 103, or 301; or Zoology 320. Horsfall.

420. **Chemistry and Toxicology of Insecticides.** Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. 1 unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. Kearns, Sternburg.

422. **Insect Physiology.** A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. 1 unit. Prerequisite: Entomology 301; a course in organic chemistry. Friedman, Larsen.

423. **Insect Behavior.** An analysis of the physiological basis of insect behavior, including a thorough study of the various sensory systems. 1 unit. Prerequisite: Entomology 301. Chadwick, Waldbauer.

426. **Seminar in Entomology.** Discussions, reviews, and appraisals of special topics in the field of entomology. ¼ to 1 unit. Prerequisite: Entomology 302; consent of instructor. Chadwick, Fraenkel, Friedman, Horsfall, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer.

430. **Biological Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. Hall.

499. **Thesis Research.** Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and ecology of insects, insect toxicology, and insect physiology. 0 to 4 units. Chadwick, Fraenkel, Friedman, Ghent, Horsfall, Jaycox, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Advanced Entomology, I.** With Entomology 302, this course provides the necessary background for all further advanced work in the department. Entomology 301 is devoted to integrated studies of the principal morphological and physiological characteristics of insects, and is to be followed by similar systematic studies in Entomology 302. 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalent. Chadwick, Friedman, Sternburg.

302. **Introduction to Advanced Entomology, II.** With Entomology 301, this course provides the necessary background for all further advanced work in the department. Entomology 302 presents a comprehensive survey of the systematics and phylogeny of the orders and principal families of insects, together with practical experience in identification of these taxa. 1 unit. Prerequisite: Entomology 301. Selander.

306. **Special Problems.** For students ready to take up some special investigation as the beginning of a thesis problem for an advanced degree. ¼ to 1 unit. Prerequisite: Any of the following: Entomology 131, 301, 302, 317, 319, 322,

or Zoology 101 or 321. CHADWICK, FRAENKEL, FRIEDMAN, GHENT, HORSFALL, JAYCOX, KEARNS, LARSEN, ROSS, SELANDER, STERNBURG, WALDBAUER.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. ALGER, SILVERMAN.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307 and consent of instructor. ALGER, SILVERMAN.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelation with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent.

317. **Classification of Insects.** Advanced study of the systematics and phylogeny of selected insect groups, with a presentation of the principles and methods of systematic entomology. 1 unit. Prerequisite: Entomology 302. SELANDER.

319. **Fundamentals of Insect Control.** The course emphasizes the principles that underlie effective control practices, rather than the details of methods used against specific pests. Both environmental and chemical factors involved in insect control are considered from their basic aspects. 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalent. HORSFALL, KEARNS.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. 1 unit. Prerequisite: Entomology 101, 103, or 301, or Zoology 320. HORSFALL.

Microbiology

The Department of Microbiology offers graduate work leading to the Master of Science and Doctor of Philosophy. Students electing microbiology as a major for an advanced degree must have had, in addition to formal training in general bacteriology or microbiology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these requirements may apply for admission if they have a grade-point average of at least 4.0.

Candidates for the Master of Science must pass a general comprehensive examination.

MOLECULAR BIOLOGY (Biophysical Chemistry)

The Department of Microbiology in collaboration with the Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the doctoral candidate with basic training in physical biochemistry and biology. Students electing this area should possess a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interests of the student. It is expected, however, that he will fulfill minor requirements in physical chemistry or biochemistry.

Courses in the Department of Microbiology directly relevant to this program are Microbiology 330, 351, 405, and 494 (same as Chemistry 494). Courses in the Department of Chemistry and Chemical Engineering especially related to this curriculum are Chemistry 346, 452, 494.

The major research areas are: (1) molecular basis of gene function; (2) struc-

tures and activities of proteins and nucleic acids; (3) intracellular organization and distribution of nucleoprotein components; (4) biosynthetic mechanisms of macromolecular replication; (5) immunochemistry.

GRADUATE FACULTY

Professors: L. L. Campbell (Head of Department), K. C. Atwood, F. M. Clark, R. D. DeMoss, R. E. Kallio, A. Nisonoff, S. Spiegelman, R. S. Wolfe.

Associate Professors: J. W. Drake, J. T. Wachsman, C. R. Woese.

COURSES FOR GRADUATES

402. Molecular Genetics. Same as Botany and Zoology 402. The nature of the gene, its mode of action, the mechanism of autosynthesis, the organization of the genetic material, and the regulation of gene action. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. Microbiological Genetics. Same as Botany and Zoology 405. Breeding systems and recombinational analysis in microorganisms, with particular emphasis on protozoa and fungi. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

420. Chemistry of Microbic Processes. The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimulation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. ¾ unit. Prerequisite: Microbiology 309 or 330 and Chemistry 234 and 350, or equivalent; consent of instructor. DeMoss.

430. Biology Ultrastructure. See Zoology 430. 1 unit. Prerequisite: Consent of instructor. Hall.

451. Experimental Virology. Experiments to illustrate the main properties of viruses. ¾ unit. Prerequisite: Microbiology 351; consent of instructor. Drake.

490. Individual Problems. ½ to 2 units. Prerequisite: Consent of instructor. Staff.

494. Chemical Basis of Biological Specificity. Same as Chemistry 494. Biological formation and interaction of large molecules; an analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles. Nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; and metabolic interrelations of these molecules. ¾ unit. Prerequisite: Chemistry 344, 346 and 350, or 450; Microbiology 330; or consent of instructor. Nisonoff, Weber.

495. Seminar. Required of all graduate students whose major is microbiology. 0 or ¼ unit. Prerequisite: Ten hours of microbiology; consent of instructor. Staff.

499. Thesis Research. 0 to 4 units. Atwood, Campbell, Clark, DeMoss, Drake, Gunsalus, Kallio, Nisonoff, Spiegelman, Wachsman, Woese, Wolfe, Wolin.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. Immunobiology. See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. Alger, Silverman.

308. Experimental Immunobiology. See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307 and consent of instructor. Alger, Silverman.

309. Cultivation and Properties of Microorganisms. Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, cultivation of bacteria, and microbiological assays. 1 unit. Prerequisite: Organic chemistry, with biochemistry recommended, and consent of instructor. WOLFE, WOLIN.

311. Food and Industrial Microbiology. The relationship of microorganisms to food manufacture and preservation and to industrial fermentation and processing and to sanitation. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201 or 309, or equivalent, and credit or registration in organic chemistry; or consent of instructor. CLARK.

312. Techniques of Applied Microbiology. A consideration, through experimentation, of the properties of the bacteria, yeasts, molds, and actinomycetes which are important to industrial processes. The methods of control of microbial processes in industry and sanitation are explored. Laboratory. ½ unit. Prerequisite: Credit or registration in Microbiology 311. CLARK.

326. Pathogenic Bacteriology. A study of the parasitism and pathogenic microorganisms: classification, morphology, cultural requirements and reactions, toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lectures and laboratory. 1 unit. Prerequisite: Microbiology 101 or 201, or 309; organic chemistry. MCCAMISH.

327. Immunochemistry. A survey of the field of immunology with emphasis on its chemical aspects. Lectures and laboratory. 1 unit. Prerequisite: Credit or registration in biochemistry or consent of instructor. NISONOFF.

330. Metabolic Regulation and Genetics of Microorganisms. Modern contributions to the science of microbiology, including considerations of the micro- and macro-molecular anatomy of the bacterial cell, the physiological and genetic behavior of microorganisms, and the role of bacterial viruses as agents involved in the transfer of genetic information. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201, or equivalent; credit or registration in biochemistry or consent of instructor; calculus strongly recommended. SYPHERD, WOESE.

351. Viruses. The study of viruses as a branch of microbiology. Statistical, physical, and chemical properties of virus particles; analysis of host-virus interaction; origin and natural relations of viruses. ¾ unit. Prerequisite: Organic chemistry; biochemistry recommended. DRAKE.

Physiology and Biophysics

The Master of Science and Doctor of Philosophy are granted in both physiology and biophysics.

Physiology

Admission to graduate study in physiology requires a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but over 3.5 are considered on an individual basis. Applicants should submit three letters of recommendation, a letter regarding intentions and qualifications, and, if possible, scores on the Graduate Record Examination. There is no departmental requirement of specific undergraduate major or minor fields, but the student whose background is deficient in chemistry, mathematics (including calculus), physics, or biological sciences (including morphology and genetics) must rectify these deficiencies early in his graduate career. Students who have not had a laboratory course in physiology should take Physiology 301 or 302 before they enter the graduate courses in advanced physiology.

Master of Science. To obtain the Master of Science, the student must offer at

least eight units in physiology and related subjects. Ordinarily, the program includes Physiology 401, 402, 403, and 404, two units from related departments or of seminar courses, and two units of Physiology 491, Individual Topics, or 499, Thesis Research. Either a research paper based on work done in Physiology 491 or a thesis must be submitted. Candidates for the Master of Science must pass a general oral examination.

Doctor of Philosophy. Admission to candidacy is based on a qualifying examination after completion of eight units or the Master of Science.

The department requires that the candidate pass a written comprehensive examination covering important areas of physiology before he is permitted to take his oral preliminary examination. Five papers are required: one each in general mammalian physiology, comparative physiology, and cellular physiology; one on his minor area; and one on physiological concepts related to his special area.

Each candidate must take, either as an undergraduate or as a graduate student, the following courses or their equivalents: Physiology 401, 402, 403, and 404 (combined mammalian, cellular, and comparative physiology); Chemistry 340 or 342 and 344; Chemistry 350 and 355; a course in statistics at the graduate level, and a course in the history and/or the philosophy of science.

In addition to satisfying the above requirements for all students, each candidate specializes in one of the following areas: mammalian physiology, comparative physiology, cellular physiology, endocrinology, neurophysiology, human anatomy and human physiology, bioclimatology, or radiobiology. An intra-departmental minor may be offered in most of these areas of specialization, chosen from sequences other than Physiology 401, 402, 403, and 404.

Minor. Graduate students majoring in other departments should meet with the departmental graduate student counselor as early as possible in their graduate studies for a discussion of a program and assignment of a departmental minor adviser. For a *sole* minor four units are required, including two courses from the sequence 401-403 as decided in consultation with their chosen departmental minor adviser. For a *first* minor three units are required, of which one must be from the sequence 401-403. For a *split* minor, two units are required, including one 400-level course which may be a seminar. For a *second* minor, two units are required. Courses recommended depend upon the needs of the individual student; usually, a sequence of courses within one area of physiology is desirable. Possible areas for minors are cellular physiology (including radiobiology, electrobiology, and biophysics), comparative physiology, mammalian physiology, human anatomy and human physiology, endocrinology, neurophysiology, and bioclimatology.

Biophysics

The objective of the program in biophysics is to give the student sufficient training in physics, chemistry, and biology to enable him to apply the conceptual, instrumental, and mathematical approaches of the physical scientist to the solution of biological problems. The graduate curriculum is administered by a committee representing both the physical and the biological sciences, with Professor Bernard C. Abbott as chairman. The curriculum is designed for two types of students, those with undergraduate training predominantly in the physical sciences or predominantly in the biological sciences.

Admission requirements are one year of college biology, one year of college physics, quantitative analysis (five hours), organic chemistry (five hours), and calculus (six hours). Applicants must have a grade-point average of at least 4.0.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in biophysics and related subjects. The required courses are Biophysics 401, 402, and two units of additional biophysics courses, a thesis, or special full examination.

For students whose major training has been in the physical sciences, the bal-

ance of courses will be selected from the biological science courses; students from the biological sciences select courses from the physical science courses. Candidates for the Master of Science must pass a general examination.

Doctor of Philosophy. A flexible approach is made to curriculum requirements. Students are required, after approximately eight units of graduate study, to pass a qualifying examination, and after sixteen units to pass a preliminary examination. An acceptable course program is given below:

(1) Mathematics, physics, and chemistry: Mathematics 343 or 345; Physics 321, 341, 342, and 381; Chemistry 342, 343, 344, and 345 (a one-year sequence including lectures and laboratory), and Chemistry 350 and 355. Certain of the required physics courses can be waived, upon approval of the committee, in cases where the student has had comparable training in advanced courses in physical chemistry. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is necessary for work in biophysics.

(2) Biology: Zoology 351 or Botany 322; three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. The course in genetics can be included as part of the three-unit requirement in biology.

(3) Biophysics: Biophysics 401 or equivalent; 402 and two additional courses in biophysics (other than research).

(4) Minor areas: Students entering from the biological sciences may declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet the approval of the committee.

Minor. Subject to the approval of the committee, candidates for the Doctor of Philosophy in other fields may take a minor in biophysics.

GRADUATE FACULTY

Professors: C. L. Prosser (Head of Department), B. C. Abbott, W. R. Ashby, R. E. Johnson, A. V. Nalbandov, E. I. Rabinowitch, F. Sargent II, F. R. Steggerda, A. B. Taylor, H. I. Teigler, G. J. Thomas, H. M. Von Foerster.

Associate Professors: J. D. Anderson, H. S. Ducoff, F. Dunn, J. Gorski, B. A. Hertig, S. G. Stolpe.

Assistant Professors: J. E. Heath, E. S. Kirk, J. R. Larsen, J. M. Parks, J. S. Willis.

Physiology

COURSES FOR GRADUATES

401. **Physiology of Systems and Organs.** Analysis of organization and function of vertebrate systems, combining the viewpoints of traditional cellular, comparative, mammalian, and human physiology. Nervous, circulatory, digestive, and excretory systems; gross metabolism. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

402. **Comparative and Adaptational Physiology.** Analysis of mechanisms of adaptation to the environment and to environmental stress, combining the viewpoints of traditional cellular, mammalian, and human physiology, with particular emphasis on the comparative approach. Homeostatic theory, nutrition,

osmotic and ionic regulation and cell membranes, respiration and metabolism, temperature relations, bioelectrics, contractile systems. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. STAFF.

403. **Cellular and Molecular Physiology.** Physicochemical analysis of cellular function and consideration of the implications of the properties of cells for the physiology of multicellular animals. Cell and its organization, cell and the organism, protein structure and specificity, regulation of cell metabolism, cellular basis of hormone action, photobiology. 1 unit. Prerequisite: One year of college-level physics; chemistry including physical and biochemistry; an upper division course in physiology; knowledge of calculus presumed. STAFF.

404. **Physiological Measurements.** Lectures and laboratories concerned with an introduction at a graduate level to current research techniques in the physiological sciences. The laboratories are problem-oriented, and students select four to six special topics, at least one of which must be in each of the following major areas of physiology: (1) nervous system and muscles; (2) mammalian and human; (3) adaptation and radiation biology, and comparative physiology; (4) molecular, cellular, and endocrinological physiology. Within each area there are problems which will fall into one or more of the following experimental categories: electrical-mechanical, chemical, and surgical. Selection of problems is done in conjunction with the course secretary so that the student obtains familiarity with techniques in each of these experimental categories and can devote some time to material of consequence relating to his own research interests. Emphasis is placed on the ability to work independently, and students give oral and written reports of their experimentation. 1¼ units. Prerequisite: Chemistry 355 or equivalent, or consent of instructor. STAFF.

410. **Mammalian Physiology Seminar.** Current trends in mammalian physiology. ½ unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

412. **Advanced Endocrinology.** Same as Animal Science, Dairy Science, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. The course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

413. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

414. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. THOMAS.

421. **Gross Human Anatomy.** A general survey of the structures of the human body with emphasis on the relations between form and function. 1 unit. Prerequisite: One semester of embryology; consent of instructor. STOLPE.

430. **Biological Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. HALL.

431. **Experimental Radiobiology.** Laboratory exercises in irradiation procedures and in the examination of biological responses to ionizing radiations. 1 unit. Prerequisite: Physiology 331 or equivalent; consent of instructor. DUCOFF.

441. **Advanced Comparative Physiology.** Same as Zoology 441. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** Same as Zoology 442. Laboratory experiments presenting comparative principles in osmotic and ionic regulation, respiration and metabolism, temperature regulation of animals, physiology of circulatory systems, of muscle, of sense organs and nervous systems. 1 unit. Prerequisite: Physiology 402, 403, 404; credit or registration in Physiology 441. PROSSER.

451. **Advanced Cellular Physiology.** Same as Botany and Zoology 451. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

461. **Fundamentals of Bioclimatology.** Same as Geography 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor. ARMSTRONG, SARGENT.

462. **Experimental Bioclimatology.** Same as Geography 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Physiology 461. ARMSTRONG, SARGENT.

464. **Advanced Human Bioclimatology.** Same as Geography 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Physiology 461. ARMSTRONG, SARGENT.

470. **Human Pathologic Physiology.** Disturbances of function in tissues and organs and their relationship to the pathogenesis of human disease. ¾ unit. Prerequisite: Two semesters of advanced physiology and one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

472. **Human Physiology Seminar.** Topics of current emphasis in human physiology. ½ unit. Prerequisite: Two semesters of advanced physiology and one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

491. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Approval of department. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.
Research may be conducted in the following areas, with the consent of the instructor:

(a) **Cellular Physiology and Radiobiology.** ABBOTT, ANDERSON, DUCOFF, PROSSER, TAYLOR.
(b) **Comparative Physiology.** ABBOTT, ANDERSON, PROSSER, WILLIS.
(c) **Mammalian Physiology.** NALBANDOV, STEGGERDA.
(d) **Human Anatomy and Human Physiology.** JOHNSON, STOLPE.
(e) **Endocrinology.** GORSKI, NALBANDOV, STOLPE.
(f) **Neurophysiology.** THOMAS.
(g) **Bioclimatology.** SARGENT.
(h) **Environmental and Stress Physiology.** JOHNSON, SARGENT, STEGGERDA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **General Physiology.** Same as Zoology 301. A consideration from the standpoint of experimental biology of functions that are common to most living

organisms. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic. ANDERSON, STAFF.

302. **Experimental Animal Physiology.** Same as Zoology 302. Organ physiology of animals with emphasis on homeostasis and physiological interactions of animals with their environment. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic. ANDERSON, STAFF.

304. **Human Factors in Engineering for Space Travel.** Same as Aeronautical and Astronautical Engineering 304. Human factors decisive in the design and operation of manned space vehicles. ½ unit. Prerequisite: Senior or graduate standing in biology, engineering, physical science, or psychology. JOHNSON, STILLWELL.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. ALGER, SILVERMAN.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307 and consent of instructor. ALGER, SILVERMAN.

312. **Endocrinology.** Same as Zoology 312. The glands of internal secretion with special reference to the vertebrates. 1 unit. Prerequisite: Physiology 301 or a course in biochemistry; consent of instructor. GORSKI.

331. **General Radiobiology.** Responses of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. DUCOFF.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology and one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Physiology of Physical Activity.** A consideration of the efficiency of physical activity in humans as related to important factors such as training, temperature, altitude, and diet. ¾ unit. Prerequisite: Physiology 103 and 234, or equivalent; consent of instructor. JOHNSON, STOLPE.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multi-disciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. LEVINE, STAFF.

Biophysics

COURSES FOR GRADUATES

401. **Advanced Biophysics, I.** Topics given are chosen from applications of the experimental methods of physics to problems of biology, including applications of thermodynamics, material transport (diffusion, barrier layers, and active transport), bioelectricity and irritability, motility, contractility, and momentum transfer. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent, calculus, physical chemistry, or consent of instructor.

402. **Advanced Biophysics, II.** Applications of the experimental and theoretical methods of physics to problems of biology, including the actions of electrical currents, electromagnetic radiations, high energy particles and radiations,

and acoustical energy on biological systems; physical phenomena in biological materials, including action currents, photosynthesis, bioluminescence, and others. ¾ unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry.

403. **Biophysical Techniques.** This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microscopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. ½ or 1 unit. Prerequisite: Credit or registration in Biophysics 402, or consent of instructor. DUNN, MATSUMOTO.

410. **Special Topics in Biophysics.** An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. ½ to 1 unit. Prerequisite: Biophysics 401 or equivalent; Biophysics 402 and 403.

411. **Seminar.** Survey of the literature in one area of biophysics, with special emphasis on student reports. ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor.

435. **Fundamentals of Cybernetics.** Same as Communications 435 and Electrical Engineering 473. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 394 or Mathematics 361, or consent of instructor. ASHBY.

436. **Problems of Cybernetics.** Same as Communications 436 and Electrical Engineering 474. Continuation of Biophysics 435. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Biophysics 435. ASHBY.

499. **Thesis Research.** Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. 0 to 4 units.

(a) **Bioacoustics.** DUNN.
(b) **Electrobiology.** ABBOTT, PROSSER.
(c) **Information Theory and Cybernetics.** ASHBY, VON FOERSTER.
(d) **Photosynthesis.** GOVINDJEE, RABINOWITCH.
(e) **Physics of Muscular Contraction.** ABBOTT.
(f) **Radiation Biology.** DUCOFF.
(g) **Cellular Biophysics.** STERN.
(h) **Vascular Dynamics.** KIRK.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Biophysics.** A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. ¾ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program.

Zoology

The Department of Zoology offers work leading to the Master of Science and Doctor of Philosophy. Five areas of specialization are available: vertebrate zoology; invertebrate zoology; embryology and basic knowledge of cells and tissues; ecology, natural history, and taxonomy; genetics, phylogeny, and evolution.

The grade-point average for admission is 4.0. Applicants with grade-point averages below 4.0 but above 3.75 will be considered on an individual basis. Applicants should have approximately twenty-five hours of zoology and two semesters each of chemistry, physics, and mathematics. Knowledge of two foreign languages is necessary, and two of the following are recommended: French, German, Russian, Latin and Greek also are helpful.

The Master of Science requires eight units of graduate credit, an acceptable thesis, and, at the end of the program, a successful oral examination. Candidates for this degree who have not had organic chemistry are required to take it, with no graduate credit. Calculus may be recommended.

Admission to advanced standing requires the master's degree or the equivalent and presupposes that the minimum science requirements specified for the master's degree have been met. Any deficiencies must be removed without graduate credit. Additional science requirements for the doctorate include at least one advanced course in physiology and statistics. Quantitative chemistry, biochemistry, and other courses may be recommended by the adviser or doctoral committee. Prior to admission to the oral preliminary examination each applicant must spend a season at an approved marine biological laboratory and pass one formal course primarily concerned with marine invertebrate fauna, and pass the written proficiency examination in any three of the five areas of specialization within the department. The preparation of a satisfactory doctoral thesis and its defense at a final examination are required. It is also required that the results of the thesis investigation be presented at a departmental or sectional seminar. Further details relating to work in specialized areas in zoology and departmental requirements may be obtained by writing to the chairman of the department, 345 Natural History Building.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology.

GRADUATE FACULTY

Professors: P. H. Silverman (Chairman of Department), B. V. Hall, D. F. Hoffmeister, L. Ingle, S. C. Kendeigh, J. B. Kitzmiller, F. J. Kruidenier, A. V. Nalbandov, D. L. Nanney, C. L. Prosser, H. M. Smith, R. L. Watterson.

Associate Professors: R. S. Bader, G. W. Barlow, M. R. Matteson, H. H. Shoemaker.

Assistant Professor: R. Davenport.

COURSES FOR GRADUATES

402. Molecular Genetics. See Microbiology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. Microbiological Genetics. See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

406. Physiology of Reproduction. Same as Animal Science 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. Nalbandov.

407. Evolutionary Theory. Genetic, systematic, ecological, and zoogeographical concepts as related to the process of evolution. 1 unit. Prerequisite: One course in genetics or consent of instructor. Bader.

408. Laboratory Methods in Physiology of Reproduction. Same as Animal Science 408. ½ to 1 unit. Prerequisite: Consent of instructor. Nalbandov.

411. Discussions in Genetics and Cytogenetics. Same as Botany 411. ¼ unit. Bader, Kitzmiller, Laughnan, Nanney, Steffensen.

412. **Advanced Endocrinology.** See Physiology 412. Course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

418. **Advanced Protozoology.** Advanced consideration of selected topics, with lectures, discussions, and readings; emphasis on laboratory practice in modern methods and techniques of studying both free-living and parasitic protozoa: collecting, culturing, and staining of representative forms. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Zoology 318 or equivalent.

419. **Topics in Experimental Protozoology.** Consideration of the advantageous employment of protozoa in modern researches concerned with basic biological problems; selected experimental topics covered by lectures, demonstrations, discussions, reports, and readings. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Consent of instructor.

420. **Experimental Invertebrate Zoology.** Study of current research problems and practice in the experimental methods used in the area of invertebrate zoology. 1 unit. Prerequisite: Zoology 320 or equivalent; consent of instructor.

421. **Cytogenetics.** See Botany 421. 1 unit. Prerequisite: Zoology 210, or Microbiology 330, or consent of instructor. LAUGHNAN, STEFFENSEN.

422. **Advanced Parasitology.** Advanced study of modern methods in helminthology. 1 unit. Prerequisite: Zoology 321 or equivalent. KRUIDENIER.

423. **Electron Microscopy.** See Biology 423. ¼ unit. Prerequisite: Background of chemistry, physics, and mathematics. HALL.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Zoology 304. MATTESON.

429. **Electron Microscopy Laboratory.** See Biology 429. ½ or ¾ unit. Prerequisite: Graduate major in a biological science with adequate background in chemistry, physics, and mathematics; credit or registration in Zoology 423; consent of instructor. HALL, PAGE.

430. **Biological Ultrastructure.** Same as Entomology, Microbiology, and Physiology 430. Lectures and reports on the fine structure of plant and animal cells and cell products with discussions of possible relationships of ultrastructure to function and of diverse interpretations of chemical-physical information as ultrastructure. 1 unit. Prerequisite: Consent of instructor. HALL.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. May be elected in successive years. ½ unit. Maximum credit for master's candidates, one unit; for doctoral candidates, three units. Prerequisite: Zoology 333 and 367. WATTERSON.

441. **Advanced Comparative Physiology.** See Physiology 441. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** See Physiology 442. 1 unit. Prerequisite: Physiology 402, 403, 404; credit or registration in Physiology 441.

444. **Concepts in Ethology.** Group discussion of problems such as stimulus filtering, spontaneity, and stereotyped motor patterns, with a new topic each semester. ½ unit. Prerequisite: Zoology 346. BARLOW.

445. **Advanced Ecology and Wildlife Management.** Seminar on modern techniques, concepts, and problems. ½ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Zoology 345 or equivalent. KENDEIGH.

446. **Physiological Ecology.** Physiological adjustments and responses of organisms to their environment. 1 unit. KENDEIGH.

451. **Advanced Cellular Physiology.** See Physiology 451. ½ unit. Prerequisite: Consent of instructor. STAFF.

455. **Advanced Genetics.** The gene in heredity, development, and evolution. 1 unit.

467. **Experimental Embryology.** 1 unit. Prerequisite: Zoology 367. WATTERSON.

499. **Thesis Research.** 0 to 4 units. Work in the following fields is offered for students registered in Zoology 499:
Anatomy, Physiology, and General Classification of Vertebrates: Vertebrate Anatomy, BADER, SMITH; Endocrinology, HALL, NALBANDOV; Functional Anatomy; Histology, DAVENPORT; Ultrastructure, HALL; Vertebrate Physiology, PROSSER.
Anatomy, Physiology, and General Classification of Invertebrates: Helminthology, KRUIDENIER, SILVERMAN; Invertebrate Zoology, MATTESON; Invertebrate Physiology, PROSSER; Parasitology, KRUIDENIER, SILVERMAN; Protozoology.
Embryology and Basic Knowledge of Cells and Tissues: Cytology, DAVENPORT; Embryology and Regeneration, MOYER, WATTERSON; Toxicology, INGLE.
Principles of Ecology, Principles of Taxonomy, Natural History: Ecology, KENDEIGH; Ethology, BARLOW; Herpetology, SMITH; Ichthyology, SHOEMAKER; Limnology, MATTESON; Mammalogy, HOFFMEISTER; Ornithology, KENDEIGH; Wildlife Management, KENDEIGH, SHOEMAKER.
Genetics, Phylogeny, Evolution: Genetics and Evolution, KITZMILLER, NANNEY; Vertebrate Phylogeny and Paleontology, BADER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students, but also open to seniors whose major is zoology. No credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Parasitology-Protozoology Seminar.

301. **General Physiology.** See Physiology 301. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic.

302. **Experimental Animal Physiology.** See Physiology 302. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic.

303. **Individual Topics.** For those who wish to study individual problems. Graduates may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. ½ or 1 unit. Prerequisite: Two years of zoology; consent of department. STAFF.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and land and fresh-water invertebrates; habits and life histories of selected forms. 1 unit. Prerequisite: One year of zoology or equivalent; consent of instructor. MATTESON.

305. **Principles of Systematic Zoology.** Theory and practice in proper procedure for formation and for determination of status names for classification of animal populations. ½ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Consent of instructor. SMITH.

306. **Biology for Teachers.** See Botany 306. ½ unit. Prerequisite: Botany 100 and Zoology 104 or 101, or a year course in general biology.

307. **Immunobiology.** Same as Botany, Entomology, Microbiology, and Physiology 307. A survey of immune responses of vertebrates and invertebrates; the immunological relationships of protozoan and helminth parasites to their hosts; the influence of immune phenomena on development and evolution. Lecture. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. ALGER, SILVERMAN.

308. **Experimental Immunobiology.** Same as Botany, Entomology, Microbiology, and Physiology 308. An introduction to laboratory techniques employed in the immunological investigations. Laboratory. ½ unit. Prerequisite: Credit or registration in Zoology 307 and consent of instructor. ALGER, SILVERMAN.

312. **Endocrinology.** See Physiology 312. 1 unit. Prerequisite: Zoology 301 or a course in biochemistry; consent of instructor. GORSKI.

318. **Protozoology.** Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. 1 unit. Prerequisite: One year of zoology or equivalent.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. 1 unit. Prerequisite: Zoology 101 or 104. GREENBERG.

321. **Parasitology.** Worm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. 1 unit. Prerequisite: One year of zoology or equivalent. KRUIDENIER.

324. **Vertebrate Paleontology.** Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Zoology 132 or 142 or Geology 102. BADER.

330. **Practical Microtechnique.** An introduction to microscopy, microphotography, and histological technique. ½ unit. Prerequisite: Histology or embryology and consent of instructor.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology; comparative anatomy, evolution, and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. 1 unit. Prerequisite: Zoology 142.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. 1 unit. Prerequisite: Zoology 132.

334. **Vertebrate Histology and Cytology.** Microscopic study of the cell, tissues, organs, and organ systems of the vertebrate body. 1 unit. Prerequisite: One year of zoology or equivalent.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. ½ unit. Prerequisite: Zoology 101 or 104. KENDEIGH.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. 1 unit. Prerequisite: Zoology 132 or 142. HOFFMEISTER.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. ½ unit. Prerequisite: Zoology 132 or 142. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. ½ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Zoology 132 or 142. SMITH.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. 1 unit. Prerequisite: One year of biology including Zoology 101; consent of instructor. SHOEMAKER.

341. **Field Ecology.** During spring vacation, study of biotic communities, mammals, birds, reptiles, amphibia, fishes, and invertebrates in various sections of North America. Outdoor camping and cooking. Transportation in University cars. ¼ unit. Prerequisite: Credit or registration in one of the following: Zoology 304, 335, 336, 337, 338, 340, 345; consent of instructor. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. ½ unit. Prerequisite: Zoology 101 or 104. SHOEMAKER.

343. **Limnology.** Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. 1 unit. Prerequisite: Zoology 101, 104, or Botany 100. MATTESON.

344. **Field Study of the Vertebrates.** Study of fish, amphibia, reptiles, birds, and mammals, with special emphasis on identification and life histories. Field trips. S; 1 unit. Prerequisite: One year of biology or equivalent.

345. **Animal Ecology.** Composition, dynamic development, and distribution of biotic communities. ¾ or 1 unit. Students enrolling for three-fourths unit are required to do field work on eight Saturdays; those enrolling for one unit are required to do field or laboratory work every Saturday, including one weekend camping trip; estimated expense, $8.50. Credit is not given for both Zoology 345 and 349. Prerequisite: One year of zoology and/or entomology, or consent of instructor; for students enrolling for three-fourths unit, concurrent registration in Zoology 342. KENDEIGH.

346. **Ethology.** The behavior of animals as interpreted through comparative studies and experimentation. Laboratory consists of observation, experiments, occasional field trips, and an individual term project. Lecture, ½ unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratoy enrollment. BARLOW.

367. **Analysis of Development.** Advanced study of basic problems in developmental biology. Major emphasis is placed on interactions at molecular, fine structural, and cellular levels and the genetic and metabolic mechanisms by which these interactions are controlled in plants and animals. Theories of differentiation are critically examined in the light of recent research. Lectures, discussions, outside readings, and student reports. 1 unit. Prerequisite: One course in each of the following areas: embryology, genetics, either cytology or histology, calculus, and organic chemistry; or equivalent.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology and one year of anthropology, geography, geology, or sociology. KENDEIGH, SHIMKIN, STAFF.

LINGUISTICS

(Including Arabic, Burmese, Chinese, Hindi, Indonesian, and Japanese)

The Department of Linguistics offers a graduate program leading to the Master of Arts and Doctor of Philosophy. The following fields of linguistics are

available for concentration: descriptive linguistics, historical linguistics, interdisciplinary study in psycholinguistics, ethnolinguistics, experimental phonetics, and mathematical linguistics.

Undergraduate preparation for the study of linguistics should include the equivalent of at least three years of foreign language experience; for historical linguistics, a broad background in the humanities and social studies; and for descriptive linguistics, the equivalent of good undergraduate training in mathematics and the sciences. Students applying for admission must have at least a 3.75 grade-point average for that portion of the work which represents the last sixty hours earned towards the bachelor's degree.

Master of Arts. Candidates for this degree must earn eight units, of which six units must be in linguistics. At least two of the required units in linguistics must be chosen from 400-level courses and must include Linguistics 401, Lingustic Analysis, I.

In addition to fulfilling the general requirements of the Graduate College and passing the comprehensive qualifying examination in general linguistics (and special subjects, if appropriate), the student also must pass the reading examination in one foreign language and must submit a satisfactory master's essay to the department.

Doctor of Philosophy. Candidates for this degree must complete at least twenty-four units of graduate work, or sixteen units beyond the master's degree. Eight of the minimum twenty-four units must be in Linguistics 499, Thesis Research. Students of descriptive linguistics must attain a grade of B or better in Linguistics 401, Linguistic Analysis, I, and Linguistics 402, Linguistic Analysis, II.

Students are encouraged to attend at least one summer session of the Linguistics Institute of the Linguistic Society of America. Up to four units of credit granted by the host university under this program may be transferred. Students of descriptive linguistics also are strongly urged to establish a vested interest and a firm basic foundation in some particular language or language family at as early a point as possible in their graduate career.

Candidates must fulfill the language requirements of the Graduate College and must pass the comprehensive qualifying examination (mentioned above for the master's degree), preferably after the first year of graduate work, unless they have already qualified for the Master of Arts in Linguistics.

Linguistically oriented courses in related departments may be counted towards the major if approved by the adviser. The head of the department acts as general adviser to each student until he selects his field of concentration, at which time he comes under the guidance of an adviser in his special area.

GRADUATE FACULTY

Professors: R. B. Lees (Head of Department), J. H. D. Allen, J. B. Casagrande, Tatjana Cizevska, H. R. Kahane, L. R. Micklesen, M. A. Morínigo, C. E. Osgood, V. Terras, A. Tovar.

Associate Professor: H. S. Maclay.

Assistant Professors: Katharine O. Aston, B. B. Kachru, F. K. Lehman, J. Yegerlehner, W. R. Zemlin.

Instructor: C. C. Cheng.

Linguistics

COURSES FOR GRADUATES

401. **Linguistic Analysis, I: Syntax.** Motivations for syntactic analysis; linguistic theories; critique of constituent-structure theories; introduction to mathematical linguistics; theory of transformational grammars; semantic theories of sentencehood. 1 unit. Prerequisite: Linguistics 300 or equivalent. Lees.

402. **Linguistic Analysis, II: Phonology.** Morphophonemic analysis of sentences; critique of taxonomic phonemics; distinctive-feature theory; analysis of stress in English. 1 unit. Prerequisite: Linguistics 401 or equivalent. LEES.

403. **Seminar in Linguistic Analysis.** Discussion of advanced topics of current interest in descriptive linguistics. 1 unit. Prerequisite: Linguistics 401. LEES.

404. **Linguistic Analysis, III: Practicum.** Classroom- and homework-solving of assorted problems in syntactic and phonological analysis of many languages. ½ unit. Prerequisite: Linguistics 401 and 402.

411. **Methods in Historical Linguistics.** Advanced analysis of genetic comparison and reconstruction, linguistic borrowing, linguistic geography, etymology, and related topics. 1 unit. Prerequisite: Linguistics 302 or 315. KAHANE.

412. **Research Seminar in Historical Linguistics.** Research work in etymology, linguistic geography, and historical syntax. 1 unit. Prerequisite: Linguistics 411 or consent of instructor. KAHANE.

415. **Seminar in Indo-European Linguistics.** Discussion and research paper on topics in Indo-European languages, their history, origins, development, and migration. Recent topics have included Latin, Vulgar Latin, and Romance languages. 1 unit. TOVAR.

424. **Linguistics and Communication.** Same as Communications 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. MACLAY.

425. **Psycholinguistics.** Same as Communications and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Communications and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. ½ or 1 unit. Prerequisite: Linguistics 425; consent of instructor. MACLAY, OSGOOD.

450. **Seminar in Ethnolinguistics.** Consideration of selected problems relating linguistic structure and language behavior to other aspects of culture. 1 unit. Prerequisite: Linguistics 370 or consent of instructor. YEGERLEHNER.

473. **Seminar in Phonetics.** Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor.

475. **Experimental Phonetics, I.** Same as Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. **Experimental Phonetics, II.** Same as Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. **Measurement of Speech, I.** Same as Speech 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Lingistics 475. ZEMLIN.

478. **Measurement of Speech, II.** Same as Speech 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 476. ZEMLIN.

490. **Special Topics in Linguistics.** Individual studies in the areas of linguistics not covered by regular course offerings. ½ to 2 units.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** An introduction to the science of descriptive linguistics. ½ or 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

301. **General Phonetics.** Same as Speech 301. Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit.

302. **Comparative Linguistics.** An introduction to the historical aspects of language. ½ or 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

303. **Non-Indo-European Linguistic Structures.** Intensive study of linguistic structure of a selected non-Western language. ¾ unit.

305. **Introduction to Applied Linguistics.** An introduction to the applications of general linguistic theory to the specific fields of stylistics, theory of translation, contrastive analyses, and the teaching and learning of foreign (and second) languages. Practical assignment work. ¾ unit. Prerequisite: Consent of instructor. KACHRU.

309. **Field Methods in Linguistics.** Same as Anthropology 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. LEHMAN, YEGERLEHNER.

310. **Advanced Field Methods in Linguistics.** Same as Anthropology 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 309 or equivalent. LEHMAN, YEGERLEHNER.

315. **Introduction to Indo-European Linguistics.** An introduction to the formation and spread of languages in the early stages of Indo-European civilization; methods of reconstruction and comparison. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences. TOVAR.

317. **Languages of the World.** Same as Anthropology 317. A survey of the main language families of the world from both genetic and typological points of view. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor.

318. **Linguistic Types.** A technical sketch of syntactic and phonological structure of four or more divergent, non-Indo-European languages. 1 unit. Prerequisite: Linguistics 300 or 317.

325. **Introduction to Psycholinguistics.** Same as Communications 325. An introductory survey of psychological and linguistic approaches to the study of communication. ½ or 1 unit. Prerequisite: An introductory course in linguistics or psychology. MACLAY.

338. **Philosophies of Language.** Same as Philosophy 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy.

351. **Area Linguistics.** Introduction to area linguistics, linguistic convergence, including borrowing. Examples taken from the Balkan language area. 1 unit. Prerequisite: Linguistics 300.

370. **Language, Culture, and Society.** Same as Anthropology and Communications 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

375. **Speech Science.** Same as Speech 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Linguistics 301 or consent of instructor. ZEMLIN.

376. **Speech Science.** Same as Speech 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Linguistics 375 or consent of instructor. ZEMLIN.

380. **Introduction to Slavic Linguistics.** Same as Russian 380. Changes in phonology and morphology from Indo-European to Common Slavic. Geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit.

387. **The Structure of English.** Same as English 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit. LEES.

388. **Linguistics in Language Learning.** Same as Rhetoric 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language; consent of instructor. ASTON.

Burmese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Burmese, I.** Introduction to a wider variety of styles and contexts of discourse and usage. Written Burmese and an orderly view of Burmese grammar. ½ unit. Prerequisite: Burmese 202 or equivalent. LEHMAN.

304. **Intermediate Burmese, II.** Concentration upon ability to engage in active and reasonably fluent discourse in Burmese, on the grammar of sentence formation and ability to read ordinary Burmese texts. ½ unit. Perequisite: Burmese 303 or equivalent. LEHMAN.

Arabic, Chinese, Hindi, Indonesian, Japanese

Courses in the above languages are offered. For further information, contact Professor Robert B. Lees, 276a Davenport Hall.

MARKETING

Graduate work may be taken in the field of marketing for a major or a minor for the Master of Science and for the Doctor of Philosophy. To do major work in this field, a student must have a grade-point average of at least 4.0 and adequate training in quantitative analysis and the social sciences.

GRADUATE FACULTY

Professors: R. FERBER, R. M. HILL, H. W. HUEGY, F. M. JONES, R. V. MITCHELL, H. G. WALES, N. WEDDING.

Associate Professors: D. M. SLATE (Head of Department), L. M. DEBOER, R. D. MILLICAN.

COURSES FOR GRADUATES

401. Marketing Principles and Problems. Functional, commodity, and institutional methods of studying marketing with particular reference to the analysis and classifications of functions, commodities, and institutions. 1 unit.

402. Marketing Methods and Problems. Selected problems in the operation and management of market institutions. 1 unit.

407. Prices and Price Policies. An examination of the role of prices in our economy; of price making under conditions of competition, monopoly, or monopolistic competition, with special emphasis on nonprice competition; an examination of business pricing policies and of their acquisitive and social implications and significance. 1 unit.

415. Merchandising Trends and Problems. The literature, trends, policies, and organization problems involved in retail merchandising. 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor.

416. Merchandising Policies and Problems. The policies and problems relating to merchandise control, personnel, publicity, and promotion; recent literature and legislation. 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor.

421. Analysis of Consumer Markets. A study of consumers and their demands. 1 unit.

422. Advanced Marketing Research. Advanced marketing research theory, literature, objectives, techniques, and problems of marketing research. 1 unit. Prerequisite: Marketing 321 or consent of instructor.

471. The Development of Marketing. The development of marketing organizations, problems, and methods in the United States from colonial times to the present. Wholesaling, retailing, market growth, consumer buying habits, advertising, selling, pricing, legislation, trade channels. 1 unit. Prerequisite: Marketing 101 or consent of instructor.

472. Sales Campaigns. Problems in managing the sales force. 1 unit.

493. Research in Special Fields. ¼ to 2 units.

499. Thesis Research. Thesis or independent study in the field of marketing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: Marketing majors do not receive graduate credit for courses in the 300 series.

Marketing 305, 325, 351, 373, and 387 will not be offered after 1965-1966.

305. Contemporary Problems in Marketing Management. The problems which marketing managers are currently facing and an analysis of the policy decisions they must make to operate effectively. ½ unit. Prerequisite: Marketing 101.

320. Marketing Research. An investigation of the development and applicability of information systems techniques to marketing problems. The marketing management process is analyzed; the underlying concepts related to the information needed to serve the processes are explored; and the incorporation of information resources into the management function is demonstrated. This course covers the use of behavioral sciences research methods, social processes and structure influences upon marketing activities, demographic variables, application of Bayesian decision theory, studies of promotional activity, simulation and programming models, planning models, and strategy formulation models which provide an analytical structure for the solution of marketing problems. ½ unit. Prerequisite: Marketing 201.

325. **Sales and Distribution Cost Analysis.** Basic techniques and principles of sales and distribution cost analysis for management control of marketing activities. ½ unit. Prerequisite: Marketing 101 or consent of instructor.

337. **Advertising and Sales Management.** Designed to enable the student, through directed and supervised investigation of selected psychological, economic, and sociological problems, to become acquainted with the methods of demand analysis and its application to the interrelationships of marketing management, advertising management, and sales management. Discussion of communication theory as it relates to the goals and means of winning patronage for the firm. Emphasis is put on the effect, or control, of the communication process. Class discussion is focused upon literature in demand stimulation and communications and the testing of relevant hypotheses. ½ unit. Prerequisite: Marketing 201.

344. **Consumer Market Behavior.** An analysis of consumer motivation, buying behavior, market adjustment and product innovation, including a survey of explanatory theories of consumer market behavior and producer reactions. This course covers behavioral aspects of the marketing process from the producer to ultimate user, or consumer. Fundamentals of product planning, development, engineering, and promotion are viewed as part of the total marketing program. Normative models of the decision-making process for winning patronage in intermediate, industrial, and consumer markets are considered. The decision-making process by consumers is evaluated with reference to psychological drives used by producers, middlemen, and consumers. ½ unit. Prerequisite: Marketing 201.

351. **Industrial Marketing.** The special problems involved in marketing materials, equipment, and supplies to manufacturers, other business firms, and institutions who use the goods in further production; determination of methods and policies appropriate to the goods and the marketing situations. ½ unit. Prerequisite: Marketing 101 or 272, or consent of instructor.

352. **Pricing Policies.** The essential nature of marketing decisions and pricing, marketing organization and the pricing process, price theories and pricing models. Contributions of operations research and behavioral sciences to pricing analysis. The relationship of pricing objectives, methods, strategies, and policies to market behavior and the goals of the firm. ½ unit. Prerequisite: Marketing 201.

360. **Marketing Logistics.** The ecology, analysis, and development of integrated distribution systems. The application of quantitative tools, economic analysis, transportation and marketing management in the analysis, and interpretation and design of the physical flow of goods through marketing network alternatives. Attention is given to the theory of market structures, transport networks, location, and cost control. Consideration is also given to site selection, warehousing, inventory management, logistic communications networks, and data control models. ½ unit. Prerequisite: Marketing 201.

370. **International Marketing.** The role of enterprise, comparative marketing and transport institutions and systems, and comparative marketing organizations and systems of administration in selected foreign countries and the United States. The managerial and operational problems of world enterprise, with emphasis on the role of ethnic and cultural differences in influencing marketing strategy. ½ unit. Prerequisite: Marketing 201; consent of instructor.

373. **Sales Management.** Management of modern sales forces selling to manufacturers, wholesalers, retailers, and consumers. Includes recruiting, selecting, compensating, training, controlling, evaluating, directing, and coordinating salesmen and includes planning and formulating policy. ½ or 1 unit. Prerequisite: Marketing 101 or 272.

380. **Advanced Marketing Management.** The appraisal and diagnosis, organization and planning, action and control of commodity and product-service distribution, marketing analysis and systems, and demand stimulation. A survey of normative models for decision-making in a variety of marketing situations and systems. Introduction to the behavioral theory of the firm and its application to different marketing targets, institutional settings, or market arrangements. Discussion of the various analytical tools available to firms for appraising, diagnosing, organizing, planning, and formulating market strategies. Principles of behavioral sciences and quantitative techniques are emphasized. A terminal course that integrates the analysis of a wide range of marketing problems and situations. ½ unit. Prerequisite: Marketing 320 and 337.

387. **Advertising Policies and Problems.** Same as Advertising 387. Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. ½ or 1 unit. Prerequisite: Advertising 281.

Note: See also Business Administration 373, Electronic Data Processing for Business.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the (1) Master of Arts or Master of Science in Mathematics and Doctor of Philosophy in Mathematics, (2) Master of Science in the Teaching of Mathematics, and (3) Master of Arts or Master of Science in Statistics and Doctor of Philosophy in Statistics. For information concerning applied mathematics, see page 252.

MATHEMATICS

For admission a beginning graduate student must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

A student should have had twenty-three hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and at least nine semester hours of more advanced work in one or more of the fields of algebra, geometry, topology, analysis, and number theory. The last requirement refers to courses equivalent to Mathematics 317-318, 327-328, 332-333, 347-348, 353-354, and 387.

Master of Arts or Master of Science in Mathematics. The departmental requirements for the master's degree in mathematics are as follows: Of the eight units required for the degree, at least six must be in mathematics, at least three of them in approved 400-level courses. Mathematics 347-348 and at least one other basic year sequence at or above the intermediate level, normally one of the sequences 317-318, 327-328, 332-333, should be included. More than one-half of this last requirement should be fulfilled in previous undergraduate work. A master's thesis is not required.

Master of Science in the Teaching of Mathematics. Candidates for the Master of Science in the Teaching of Mathematics must earn four units in mathematics, two units in education, and two units in electives. Requirements are two units from Mathematics 317, 318, 327, and 328; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor Wilson M. Zaring, 303 Altgeld Hall.

Doctor of Philosophy in Mathematics. The departmental requirements for the Doctor of Philosophy are as follows: Of the sixteen units of course work required before the preliminary examination, eight must be in mathematics courses at the 400 level for students with a full outside minor, and ten must be in mathematics courses at the 400 level for students with one internal minor. Majors and minors within the department are chosen from the following six fields: analysis (including linear spaces, theory of probability, and analytic number theory), algebra (including group theory and mathematical logic), geometry, topology, statistics, and applied mathematics. At least two courses at the 400 level are required for an internal minor. The language requirement may be met in any two of three languages, French, German, and Russian. The Graduate College requirements concerning residence, oral examination, research units after the oral examination, thesis, and final examination must be satisfied.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology. This program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee.

For admission to full standing a beginning graduate student must have a grade-point average of not less than 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is helpful. Students are admitted on limited status.

Master of Arts or Master of Science in Statistics. A candidate for the master's degree in statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 18 to 25) he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

Doctor of Philosophy in Statistics. The thesis for the Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics, and one representing mathematics or a field of application.

A candidate for the Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315, 347, or equivalent; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Mathematics Department and including all courses in statistics listed jointly by the Mathematics Department and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

Candidates for a Doctor of Philosophy taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

GRADUATE FACULTY

Professors: P. T. Bateman (Head of Department), R. G. Bartle, C. R. Blyth, W. W. Boone, D. G. Bourgin, D. L. Burkholder, S. S. Cairns, M. M. Day, J. L. Doob, D. G. Gilles, M. H. Heins, A. Heller, F. E. Hohn, P. W. Ketchum, R. G. Langebartel, H. Levy, C. W. Mendel, H. J. Miles, D. E. Muller, R. E. Pingry, I. Reiner, E. J. Scott, M. Suzuki, W. J. Trjitzinsky, C. Ionescu Tulcea, H. E. Vaughan.

Associate Professors: R. E. Block, R. W. Carroll, Josephine H. Chanler, W. A. Ferguson, S. I. Goldberg, J. W. Gray, N. T. Hamilton, Mary-Elizabeth Hamstrom, L. L. Helms, R. P. Jerrard, B. H. McCormick, H. A. Osborn, E. T. Parker, Echo D. Pepper, J. W. Peters, W. J. Poppelbaum, J. J. Rotman, L. A. Rubel, Jewell E. Schubert, G. Takeuti, Alexandra Ionescu Tulcea, J. H. Walter, R. A. Wijsman, W. M. Zaring.

Assistant Professors: O. G. Aberth, K. I. Appel, J. W. Armstrong, M. Barr, Geneva G. Belford, I. D. Berg, R. L. Bishop, G. R. Blakley, P. G. Braunfeld, T. A. Eagon, D. J. Eustice, C. W. Gear, F. B. Knight, L. R. McCulloh, G. A. Metze, H. Paley, Irma M. Reiner, N. J. Rothman, D. Sachs, W. J. Sanders, W. Stinespring, Patricia A. Tucker, P. M. Weichsel, E. C. Weinberg, J. E. Wetzel.

Instructors: J. R. Alexander, Jr., G. E. Brown, F. E. Hoffman, W. J. Leahey, C. E. Linderholm, Chin-Pi Lu, T. G. McLaughlin, G. H. Orland, J. C. Sanwal, D. R. Sherbert, K. Witz.

COURSES FOR GRADUATES

401. Second Course in Abstract Algebra, I. The Noether isomorphism theorem for groups; permutation groups; simplicity of the alternating group; Jordan-Holder theorem; Euclidean rings; fundamental theorem of Galois theory. 1 unit. Prerequisite: Mathematics 317, 318.

402. Second Course in Abstract Algebra, II. Wedderburn theorem on semi-simple rings; fundamental theorem of finitely generated Abelian groups (with application to canonical forms for matrices); Krull-Schmidt theorem; tensor products; exterior algebra. 1 unit. Prerequisite: Mathematics 401.

403. Theory of Rings. Ideal theory in commutative rings; structure of noncommutative rings. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

404. Group Theory. Structure of groups, derived groups, nilpotence and solvability, extensions and products. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

405. Theory of Fields. Further development of the theory of fields covering topics from valuation theory, ideal theory, units in algebraic number fields, ramification, function fields, local class field theory. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

406. Homological Algebra. An axiomatic treatment of the algebraic systems basic in topology. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

407. **Group Representation Theory.** Representation of groups by linear transformations, group algebras, character theory, modular representations. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

408. **Lie Groups.** 1 unit. Prerequisite: Mathematics 332, 404, and 441.

414. **Logical Foundations of Mathematics.** A discussion of the logical and philosophical foundations of mathematics. 1 unit. Prerequisite: Philosophy 333, or Mathematics 317 or 347, or consent of instructor.

415. **Advanced Topics in the Theory of Groups.** 1 unit. Prerequisite: Consent of instructor.

416. **Advanced Topics in Abstract Algebra.** 1 unit. Prerequisite: Consent of instructor.

420. **Projective Geometry.** 1 unit. Prerequisite: Mathematics 328.

422. **Algebraic Geometry.** 1 unit. Prerequisite: Mathematics 328.

423. **Differential Geometry.** 1 unit. Prerequisite: Mathematics 343.

424. **Riemannian Geometry.** Local and global properties of Riemannian manifolds. 1 unit. Prerequisite: Mathematics 423.

425. **Differentiable Manifolds, I.** Foundations of modern differential geometry, including multilinear algebra, exterior calculus, Stokes' theorem, Frebenius' theorem, affine connections, elements of Riemannian geometry and Lie groups, sheaves, cohomology of manifolds, the DeRham theorem, differentiable fiber bundles, the holonomy theorem, the Hodge theorem, elements of complex analytic manifolds. 1 unit. Prerequisite: Mathematics 318 and 332.

426. **Differentiable Manifolds, II.** See description above for Mathematics 425. 1 unit. Prerequisite: Mathematics 425.

428. **Topics in Geometry.** 1 unit. Prerequisite: Consent of instructor.

430. **Elementary Geometry from a Modern Viewpoint.** Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. **Algebraic Topology, I.** Continuation of Mathematics 333. Categories and functors, homotopy groups, singular homology, Kunneth theorem, products in cohomology. 1 unit. Prerequisite: Mathematics 333.

432. **Algebraic Topology, II.** Continuation of Mathematics 431. CW-complexes, Cech homology, duality, spectral sequences, and other topics. 1 unit. Prerequisite: Mathematics 431.

433. **Fibre Spaces.** 1 unit. Prerequisite: Consent of instructor.

434. **Combinatorial and Differential Topology.** 1 unit. Prerequisite: Consent of instructor.

435. **General Topology.** Separation; global and local compactness and connectedness; compactification and completion; function spaces; other topics. 1 unit. Prerequisite: Mathematics 332 or consent of instructor.

438. **Topics in Topology.** 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** 1 unit. Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** Application of the elementary theory is made to the study of conformal mappings, Riemann surfaces, entire and meromorphic functions. 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. **Real Analysis, I.** Lebesgue measure on the real line, integration and differentiation of real functions, elementary applications to harmonic analysis. 1 unit. Prerequisite: Mathematics 347 or equivalent.

442. **Real Analysis, II.** Metric spaces, introduction to functional analysis, integration on general measure spaces. 1 unit. Prerequisite: Mathematics 441.

443. **Ordinary Differential Equations.** Existence, uniqueness, and continuation of solutions; topics selected from: the theory of linear differential operators, Sturm-Liouville theory, stability theory, qualitative theory of differential equations. 1 unit. Prerequisite: Mathematics 347 and a first course in ordinary differential equations.

444. **Partial Differential Equations.** 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable, II.** 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** Geometrical properties of Hilbert spaces; linear operators; the spectral theory for self adjoint and related operators. 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** Geometrical properties of Banach spaces; bounded linear operators; applications to analysis; linear topological spaces. 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** Properties of normed rings; representation as rings of continuous functions or rings of bounded operators; applications to spectral theory, harmonic analysis, etc. 1 unit. Prerequisite: Mathematics 318 and 446 or 447.

451. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 455.

457. **Analytical Problems in Numerical Analysis.** A study of the various mathematical problems arising when one formulates problems in analysis, such as the solution of ordinary or partial differential equations, for treatment by an automatic digital computer. Among the problems discussed are convergence of difference equations to differential equations, and stability of methods for approximately solving ordinary and partial differential equations. 1 unit. Prerequisite: Mathematics 387 or consent of instructor.

458. **Numerical Integration of Differential Equations.** Existence theory of Picard; Lagrangian integration methods; absolute and relative stability; Schur's theorem; integration of systems; orthogonal polynomials; Gauss quadrature; Tschebycheff quadrature and Bernstein's theorem; special methods for initial value problems. 1 unit. Prerequisite: Mathematics 455 or consent of instructor.

459. **Topics in Hydrodynamics.** 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

461. **Applied Stochastic Processes.** Introduction to topics such as spectral analysis, filtering theory, and prediction theory of stationary processes, Markov chains and Markov processes. 1 unit. Prerequisite: Mathematics 346, 347.

463. **Information Theory.** Same as Electrical Engineering 463. Mathematical models for information channels and sources: existence theorems for and construction of error-correcting codes. 1 unit. Perequisite: Mathematics 361 or Electrical Engineering 433.

468. **Topics in Analysis.** 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision-making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to nonsequential and sequential decision-making in practice. 1 unit. Prerequisite: Consent of instructor.

472. **Econometrics.** Same as Economics 472. Point estimates of parameters for systems of simultaneous equations; properties of various estimators; hypothesis testing and confidence intervals for econometric models. 1 unit. Prerequisite: Mathematics 363 and 315 or consent of instructor.

473. **The Theory of Testing Hypotheses.** Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. 1 unit. Prerequisite: Consent of instructor.

474. **The Theory of Estimation.** Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. 1 unit. Prerequisite: Consent of instructor.

478. **Topics in Statistics.** 1 unit. Prerequisite: Consent of instructor.

488. **Topics in Applied Mathematics.** 1 unit. Prerequisite: Consent of instructor.

489. **Seminar in Applied Mathematics.** 1 unit. Prerequisite: Consent of instructor.

490. **Reading Course.** 1 to 2 units. Prerequisite: Consent of instructor.

493. **Proseminar.** An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. 1 unit. Prerequisite: Mathematics 347; credit or registration in Mathematics 348.

499. **Thesis Research.** 0 to 4 units. Prerequisite: Consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Theory of Sets and the Real Number System.** This course deals with elementary naive set theory and the development of the integers, the rational numbers, and the real numbers; principal emphasis is upon the mathematical needs of the secondary teacher. 1 unit. Prerequisite: One year of calculus or consent of instructor.

301. **Fundamental Concepts of Algebra.** 1 unit. Prerequisite: One year of calculus or consent of instructor.

302. **Topics in Geometry.** Historical development of geometry, including tacit assumptions made by Euclid, Euclid's Fifth Postulate and its equivalents and the discovery of non-Euclidean geometries; geometry as a mathematical structure; finite geometries; geometry as a study of invariants of set transformations; projective geometry; applications of group theory to geometry; vector geometry. 1 unit. Prerequisite: One year of calculus or consent of instructor.

303. **Advanced Aspects of Euclidean Geometry.** Selected topics from geometry as for example, circumcircle, the nine-point circle, theorem on centroid and orthocenter, the construction of regular figures, isometries in the plane and space, rotations and translations, fixed points, ordered and affine geometries, geometry of inversive plane. 1 unit. Prerequisite: One year of calculus or consent of instructor.

305. **Teachers' Course.** A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school

students are also considered. ½ or 1 unit. Prerequisite: One year of calculus or consent of instructor.

306. **Selected Mathematical Topics for Secondary School Teachers, I.** This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

307. **Selected Mathematical Topics for Secondary School Teachers, II.** This course deals with the teaching of the following topics in high school mathematics: variables in geometry; logic analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

311. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

312. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

314. **Introduction to Set Theory and Mathematical Logic.** In general, this course supplies the set-theoretic and logical preliminaries for graduate work in mathematics. Contents: sets, relations, and mappings; the notions of constant and variable; the integers; cardinal and ordinal numbers; Zorn's Lemma; the real numbers; informal account of the propositional calculus and first order functional calculus; informal account of various axiomatic theories. 1 unit. Prerequisite: One year of calculus.

315. **Linear Transformations and Matrices.** 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** 1 unit. Prerequisite: Mathematics 327.

332. **Introduction to Set Theory and Topology.** Informal set theory, cardinals, ordinals, Zorn's Lemma, axiom of choice, topology of metric spaces, introduction to general topological spaces, and other topics. 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Introduction to Algebraic Topology.** Fundamental group, complexes, homology, simplicial approximation, structure of Abelian groups, exact sequences, axioms for homology. 1 unit. Prerequisite: Mathematics 318, 332, or consent of instructor.

341. **Differential Equations.** 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** 1 unit. Prerequisite: Mathematics 341.

343. **Advanced Calculus.** 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** 1 unit. Credit is not given for both Mathematics 345 and 349. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take

Mathematics 348. Credit is not given for both Mathematics 346 and 348. 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** 1 unit. Credit is not given for both Mathematics 346 and 348. Prerequisite: Mathematics 347.

349. **Differential Equations and Orthogonal Functions.** An honors course for students with superior mathematical ability. Credit is not given for both Mathematics 349 and 345. 1 unit. Prerequisite: Grade of B or higher in Mathematics 347; and, for undergraduates, registration in Mathematics 249.

350. **Topics in Pure Mathematics.** This is a survey course in pure mathematics for secondary school mathematics teachers. It deals with topics in number theory, topology, and analysis. 1 unit. Prerequisite: Consent of instructor.

351. **Topics in Applied Mathematics.** This is a survey course in applied mathematics for secondary school mathematics teachers. It deals with topics in the application of matrices to physical and social sciences, applications of Boolean algebra, game theory. 1 unit. Prerequisite: Consent of instructor.

353. **Elementary Theory of Numbers.** 1 unit. Prerequisite: One year of calculus.

354. **Elementary Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 or 353.

358. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. ½ unit. Prerequisite: Mathematics 111 or 112.

359. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. A grade of A or B in this course admits the student to Mathematics 315, 361, 363 and, with consent of instructor, to Mathematics 343. ½ unit. Prerequisite: Mathematics 358.

361. **Theory of Probability.** 1 unit. Prerequisite: One year of calculus.

362. **Finite Differences.** 1 unit. Prerequisite: One year of calculus.

363. **Advanced Statistics.** 1 unit. Prerequisite: One year of calculus.

364. **Advanced Statistics.** 1 unit. Prerequisite: Mathematics 363.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Agronomy 365. A study of methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Students are expected to solve problems on the computers. 1 unit. Prerequisite: Mathematics 195 and a course in statistics or statistical methods or equivalent, or consent of instructor.

366. **Theory of Probability.** Continuation of Mathematics 361. Topics covered may include random walks, Markov chains. branching processes, birth and death processes, and theory of Queues. 1 unit. Prerequisite: Mathematics 361 or 363.

371. **Actuarial Theory.** 1 unit. Prerequisite: One year of calculus. PETERS.

372. **Actuarial Theory.** 1 unit. Prerequisite: Mathematics 371.

375. **Nonparametric Inference.** Nonparametric tests of hypotheses concerning means, variances, regression, and correlation coefficients; methods, depending on ranks; the efficiency of nonparametric tests. 1 unit. Prerequisite: Mathematics 361 or 363.

381. **Vector and Tensor Analysis.** 1 unit. Prerequisite: Mathematics 343, or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

386. **Laplace Transforms.** 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Analysis.** 1 unit. Prerequisite: Senior standing, calculus, and a course in differential equations, or consent of instructor.

388. **Mathematical Methods in Engineering and Science.** 1 unit. Prerequisite: Mathematics 343.

391. **Boolean Algebras with Applications to Computer Circuits, I.** Same as Electrical Engineering 391. An introduction to Boolean algebra with a discussion of the elementary applications to set theory, logic, and both relay and electronic switching circuits. The Harvard chart method and other methods for circuit simplification are treated both as applied to single output and multiple output circuits. ½ or 1 unit. Prerequisite: Senior standing; consent of instructor.

392. **Boolean Algebras with Applications to Computer Circuits, II.** Same as Electrical Engineering 392. The notion of time as a parameter is introduced into the theoretical treatment of switching circuits. Examples of synthesis of time-dependent circuits are given using mathematical techniques. ½ or 1 unit. Prerequisite: Mathematics 391.

394. **Logical Design of Automatic Digital Computer Circuits.** Same as Electrical Engineering 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Mathematics 294 and senior standing, or consent of instructor.

395. **Advanced Programming.** This course is devoted to a discussion, by means of classroom and laboratory examples, of the efficient use of computers for solving problems. Particular emphasis is given to examples in which limitations of computers have been overcome. 1 unit. Prerequisite: Mathematics 195 and senior standing, or consent of instructor.

397. **Mathematical Theory of Data Processing.** Mathematical structure and automatic processing of extensive files of data are developed employing methods from statistics, graph theory, and information theory. Topics discussed include: the selective screening and classification of data (pattern recognition, machine abstracting, optimum encoding, least square adjustment of data); and file organization and maintenance (information retrieval, indexing, scheduling). 1 unit. Prerequisite: Mathematics 195 or consent of instructor.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, is offered by various graduate departments in the sciences and engineering. A graduate student interested in applied mathematics should register as a major in the department of his choice. In consultation with his adviser he should plan a basic course of study which will serve as preparation for subsequent specialization and research in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design.

MECHANICAL AND INDUSTRIAL ENGINEERING

The Department of Mechanical and Industrial Engineering offers work leading to the Master of Science and Doctor of Philosophy. Advanced study and professional training are offered in the general fields of power, design, production, and industrial engineering.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements of the Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 4.0. The applications of those with grade-point averages below 4.0 but above 3.6 are individually reviewed by the graduate committee and admission is granted if credentials are satisfactory. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

Except under unusual circumstances the maximum number of credits which is permitted in any course whose number ends in 8 or 9 is three units toward the requirements for a master's degree. A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is then required.

For further information see *Notes on Graduate Study,* available from the Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the departmental chairman of the graduate committee, Professor Seichi Konzo.

GRADUATE FACULTY

Professors: H. H. Korst (Head of Department), H. D. Bareither, E. L. Broghamer, B. T. Chao, W. L. Chow, L. E. Doyle, G. W. Harper, W. S. Harris, E. F. Hebrank, J. A. Henry, W. L. Hull, S. Konzo, J. L. Leach, R. J. Martin, J. C. Miles, L. C. Pigage, E. I. Radzimovsky, D. G. Ryan, F. Seyfarth, S. L. Soo, W. F. Stoecker, K. J. Trigger.

Associate Professors: W. E. Bair, J. C. Chato, R. G. Hering, B. A. Hertig, E. A. Jackson, D. H. Offner, R. P. Strout, B. F. von Turkovich.

Assistant Professors: A. L. Addy, R. W. Adkins, A. M. Clausing, R. C. Dimick, L. D. Savage, Jr.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics and Transport Properties.** Thermodynamic and microscopic considerations for the prediction of properties. Caratheodory principle; relations between properties; microscopic description based on classical statistics; statistical equilibrium and trend toward equilibrium fluctuations; thermodynamics and transport properties; implication of wave mechanics. 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor. Soo.

402. **Irreversible Thermodynamics.** Statistical considerations based on wave mechanics; gases and relativistic modifications; radiation and high temperatures; solids and liquids, systems at low temperatures; reactive systems; electrical and magnetic properties; fluctuations and irreversible thermodynamics. 1 unit. Prerequisite: Mechanical Engineering 401. Soo.

403. **Fundamentals of Combustion.** Same as Aeronautical and Astronautical Engineering 438. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Mechanical Engineering 305 or Aeronautical and Astronautical Engineering 216.

404. **Gas Dynamics.** Introduction to theoretical gas dynamics; properties of com-

pressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multi-dimensional problems. 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. CHOW, KORST.

405. **Convective Heat Transfer.** Fundamentals of convective heat transfer; calculation of heat transfer within conductor and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. CHAO, HERING.

406. **Heat Conduction in Solids.** Fundamentals of heat conduction in isotropic and anisotropic solids; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques. 1 unit. Prerequisite: Mechanical Engineering 306, Mathematics 346, or consent of instructor. CHAO, HERING.

407. **Selected Topics in Gas Dynamics.** Theoretical analysis of nonsteady processes including scavenging, pulse jet, shock tube, and complex compressor. Includes an introduction to high velocity laboratory techniques. 1 unit. Prerequisite: Mechanical Engineering 404. CHOW, KORST.

408. **Laboratory Investigation in Thermodynamics.** Special investigations involving thermodynamics analysis, thermodynamic properties, and performance of physical and chemical systems. ½ to 1½ units. Prerequisite: One-year course in thermodynamics; one half-year course in power laboratory. BAIR, DIMICK, JACKSON, KORST, SOO.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigation in flow, metering, heat transfer, heat exchanger performance and design. ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. ADDY, BAIR, CHAO, CHOW, CLAUSING, KORST, SAVAGE.

410. **Thermal Radiation.** Fundamentals of radiant energy transport in absorbing and non-absorbing media; pyrometry; applications to selected problems involving combined energy transport mechanisms. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. CHAO, HERING.

421. **Heating and Air Conditioning.** Advanced study of heating, ventilating, and air conditioning. Factors affecting heat loss and heat gain of building, physiological effects of environment, equipment design of heat transfer equipment. Individual problems. 1 unit. Prerequisite: Undergraduate course in heating, ventilating, and air conditioning. STOECKER.

423. **Refrigeration Theory and Application.** Advanced study of processes and cycles; design problems; and special applications. 1 unit. Prerequisite: Undergraduate course in refrigeration. CHATO, STOECKER.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. ½ to 1½ units. CHATO, STOECKER.

429. **Laboratory Investigation in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. ½ to 1½ units. Prerequisite: Two semesters of power laboratory or equivalent. CHATO, HARRIS, HERTIG, KONZO, STOECKER.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbo-compressors; regulation; rotary positive blowers. 1 unit. Prerequisite: Mechanical Engineering 205, 206, and 212; or Theoretical and Applied Mechanics 232, or Aeronautical and Astronautical Engineering 211. KORST.

438. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. ½ to 1½ units. Prerequisite: One-year course in power laboratory. HEBRANK, HULL, STROUT.

441. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper considerations of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. RYAN.

442. **Linkage Synthesis.** Geometry of constrained motion in two and three dimensions. Application of mathematical and other techniques to the synthesis of mechanisms. 1 unit. Mechanical Engineering 342 or consent of instructor. BROGHAMER.

443. **Dynamics of Machinery.** Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, flywheels; special topics. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, RYAN.

445. **Design of Internal Combustion Engines.** Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. **Laboratory Investigations in Machine Design.** Special investigations in machine design. ½ to 1½ units. ADKINS, BROGHAMER, OFFNER, RADZIMOVSKY, RYAN.

451. **Metal Cutting.** A study of the theoretical factors involved in metal cutting and forming. Basic mechanics of machining processes; friction and surface finish; temperatures developed during machining operations and the effect upon chip formation. Analysis of experimental data. Lecture and discussion periods. Survey of current literature and special topic assignments. 1 unit. Prerequisite: Undergraduate courses in advanced metal processing and heat treatment of metals or physical metallurgy. TRIGGER.

452. **Deformation and Mechanical Processing of Metals.** Theoretical and experimental aspects of deformation and mechanical processing of metals. Plastic deformation; fracture and fatigue; impact stresses and stress waves in metals; thermal and residual stresses; plastic forming of metals and its influence on the properties. 1 unit. Prerequisite: Mechanical Engineering 451 and Metallurgical Engineering 408. TRIGGER.

458. **Laboratory Investigations in Production.** Special investigations in field of production, particularly in materials processing, metal cutting, and production engineering. ½ to 1½ units. CHAO, TRIGGER, VON TURKOVICH.

493. **Seminar.** Presentation and discussion of significant developments in mechanical engineering. No credit. KONZO.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Thermodynamics.** Basic considerations of the three laws of thermodynamics; elementary statistical principles for the prediction of properties of pure substances and mixtures; transport properties; electric and magnetic systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or equivalent; consent of instructor. DIMICK, JACKSON, SOO.

302. **Nuclear Power Engineering.** Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptation and economics. ¾ or 1 unit. Prerequisite: Consent of instructor.

304. **Direct Energy Conversion.** Direct conversion of chemical, nuclear, and solar energies into electricity by electrochemical, thermionic, thermoelectric, photoelectric, photochemical, ferroelectric, magnetohydrodynamic, and plasma systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor; Mathematics 345. Soo.

305. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or consent of instructor. ADDY, CHOW.

306. **Industrial Heat Transfer.** Theory and application of numerical, analogical, and experimental methods to selected heat transfer problems; application of principles of convection, condensation, and boiling heat transfer to design of heat exchange equipment. 1 unit. Prerequisite: Undergraduate courses in fluid mechanics and heat transfer. CLAUSING, HERING, SAVAGE.

309. **Experimental Gas Dynamics.** Experimental investigation of problems in the field of compressible fluid flow within enclosed channels. 1 unit. Prerequisite: Mechanical Engineering 305 or consent of instructor. ADDY, CHOW.

311. **Instrumentation and Measurements.** Instruments and measuring equipment for flow, temperature, pressure, speed, and gas analysis. ¾ or 1 unit. STROUT.

312. **Theory of Controls.** Introduction to the theory of controls. Dynamical analysis of physical systems; steady-state operations; graphical and analytical methods of analysis; applications. ¾ or 1 unit. Prerequisite: Consent of instructor. VON TURKOVICH.

314. **Lubrication.** The theoretical basis of lubrication; hydrodynamic bearing theory; properties of lubricants; methods of testing; lubrication methods and appliances; study of the lubrication requirements of machines of many kinds. ¾ or 1 unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. ADKINS, OFFNER, RADZIMOVSKY.

332. **Theory of Internal Combustion Engines.** Study of reciprocating engine cycles. including thermodynamics and combustion, considering such factors as fuel-air mixture, variable specific heats, chemical equilibrium and dissociation and heat losses; supercharging; flow through valves and manifolds; mixture distribution; bearings and lubrication; and effects of variables on performance. ¾ or 1 unit. Prerequisite: Undergraduate course in internal combustion engines. HULL.

341. **Engineering Analysis and Design.** Correlation of previously acquired design experience with the creative problems of synthesis and analysis that depend upon design judgment. ¾ or 1 unit. Prerequisite: Mechanical Engineering 271 or consent of instructor. BAYNE, BROGHAMER, WHISENAND.

342. **Kinematic Analysis and Synthesis.** Geometry of constrained motion; application of mathematical and other techniques to the kinematic analysis and synthesis of mechanisms. ¾ or 1 unit. Prerequisite: Undergraduate course in kinematics or consent of instructor. BROGHAMER.

343. **Dynamics of Machinery.** A course complementary to the undergraduate course with emphasis on the analytical approach to the study of dynamic forces in machines, balancing, critical speeds, shaft vibrations, governors, and gyroscopes. ¾ or 1 unit. Prerequisite: Mechanical Engineering 221 or consent of instructor.

388. **Machine Tool Systems Analysis.** A study of the components, their analysis and synthesis in machine tool systems. Power components, precision motion, dynamic response of machine skeleton, linear and nonlinear conditions, control elements, and computer control of machines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186, 271, or consent of instructor. VON TURKOVICH.

Industrial Engineering

COURSES FOR GRADUATES

416. **Design of Construction and Industrial Operation, I.** Same as Civil Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in Civil or Industrial Engineering; credit or registration in Mathematics 363; or consent of instructor.

417. **Design of Construction and Industrial Operations, II.** Same as Civil Engineering 417. Continuation of Industrial Engineering 416. 1 unit. Prerequisite: Industrial Engineering or Civil Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

453. **Work Measurement.** A study of special problems of line balance, interference, and automation work loads as required to establish work standards (or production standards). 1 unit. Prerequisite: Industrial Engineering 332. PIGAGE.

454. **Production Engineering.** Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

458. **Laboratory Investigations in Industrial Engineering.** Special investigations of such problems as optimization of operations, programming systems, work standards, plant layout, and flow of materials. ½ to 1½ units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

332. **Standard Time Systems.** The study of development, uses, and limitations of standard time data and predetermined time system. ¾ or 1 unit. Prerequisite: Industrial Engineering 232. PIGAGE.

333. **Engineering Applications of Statistics.** Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. ¾ or 1 unit. Prerequisite: Mathematics 263 or 363. HENRY.

350. **Manufacturing Process and Tool Design.** A study of and exercises in the design of manufacturing processes and tools for maximum efficiency; the theory and utilization of information transfer systems in manufacturing and programming of numerical control devices. ¾ or 1 unit. Prerequisite: Industrial Engineering 282 or a course in engineering economy. DOYLE.

357. **Safety Engineering.** The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. ¾ or 1 unit. HARPER.

358. **Problems in Safety Engineering.** Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. ¾ or 1 unit. Prerequisite: Industrial Engineering 357, or 235 and consent of instructor. HARPER.

359. **Industrial Fire Protection.** Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. ¾ or 1 unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

386. **Industrial Engineering Analysis.** Analysis and development of analytical techniques for the solution of problems in industrial engineering. Application of statistical methods to uncertainty problems. Analysis of linear programming techniques appropriate to the solution of allocation problems dealing with materials, money, men, and machines. Queueing theories applied to maintenance and inventories. ¾ or 1 unit. Prerequisite: Mathematics 263; Industrial Engineering 286.

MICROBIOLOGY

See descriptions and course listings under Life Sciences, page 224.

MINING, METALLURGY, AND PETROLEUM ENGINEERING

The Department of Mining, Metallurgy, and Petroleum Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy. The prerequisite for graduate work in metallurgical or mining engineering is the equivalent of the undergraduate courses in either of these majors which are required for the Bachelor of Science at the University of Illinois. For these major fields a Bachelor of Science in some related field may also be acceptable.

Those wishing to specialize in petroleum engineering or in the more general area of petrophysics should have a Bachelor of Science in engineering with advanced courses in mathematics, chemistry, and physics and/or geology.

A candidate for the Master of Science is required to have a minimum of eight units of graduate work, including a thesis. If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. The thesis requirement is not waived for research assistants.

Students desiring to work for the Doctor of Philosophy are required to pass the departmental qualifying examination. This examination must be taken no later than the end of the first semester after receiving the Master of Science from this department, or no later than the end of the second semester in residence, if the student has a Master of Science from some other department or university.

The minor requirement of the Graduate College for the Doctor of Philosophy may be satisfied by taking courses in fields such as ceramics, chemistry, geology, mathematics, theoretical and applied mechanics, nuclear engineering and physics.

GRADUATE FACULTY

Professors: T. A. READ (Head of Department), P. A. BECK, R. W. BOHL, W. H. BRUCKNER, A. J. DE WITTE, E. J. ECKEL, J. J. GILMAN, D. S. LIEBERMAN, M. METZGER, B. G. RICKETTS, H. E. RISSER, W. D. ROSE, T. J. ROWLAND, A. E. SCHEIDEGGER, N. STREET, R. M. THOMSON, C. A. WERT, F. D. WRIGHT.

Associate Professors: C. J. Altstetter, H. K. Birnbaum, A. C. Forsyth, C. M. Wayman.

Mining Engineering

COURSES FOR GRADUATES

401. **Advanced Mineral Dressing and Coal Preparation.** Advanced theory and practice of mineral dressing and coal preparation processes. 1 unit.

402. **Mine Valuation, Taxation, and Mineral Economics.** A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. 1 unit.

403. **Advanced Mine Administration.** Current methods and systems of mine administration in use by major mining corporations. 1 unit.

405. **Advanced Mine Ventilation.** Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. 1 unit. Prerequisite: Consent of instructor.

406. **Design of Underground Openings.** Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. 1 unit. Prerequisite: Mining Engineering 356.

497. **Special Problems.** Individual studies in areas of mining of petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite; Consent of instructor.

499. **Thesis Research.** Individual research in some phase of the general field of mining or petroleum engineering under the supervision of a member of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Mineral Processing, II.** Crushing, grinding, flotation, proximate analysis of coal, pumping of fluid-solid mixtures, quality control in ore dressing. ¾ unit. Prerequisite: Mining Engineering 272.

302. **World Mineral Economics.** The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. ¾ or 1 unit.

303. **Materials Handling: Fluids.** Design of water systems for unwatering and dust control in mines; compressed air distribution systems and analysis of mine ventilation and air conditioning. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 234; Mechanical Engineering 209 or Chemistry 344.

304. **Mine Safety Engineering.** A detailed study of mine accident statistics, causes of accidents, accident prevention; consideration of insurance rates and cost of mine accidents; psychology of accident prevention; state and federal mining laws as related to safety. ¾ or 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Consent of instructor.

351. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Senior standing in engineering or geology, or consent of instructor.

353. **Sampling, Exploration, Valuation.** Theory of sampling applied to mineral deposits and concentrating plants; geological principles of exploration; surface and subsurface exploration; valuation. ¾ or 1 unit. Prerequisite: Geology 101 and 130; Mathematics 263.

356. **Rock Mechanics.** Mechanical properties of rocks; design of mine openings in bedded, massive, and fractured rock; methods of support; drilling; blasting. ¾ or 1 unit. Prerequisite: Mining Engineering 257 and 351.

360. **Analysis and Design of the Mining System.** Analyses of unit operation cycles and production methods; design of materials handling systems and applications of operations research. 1 unit. Prerequisite: Mathematics 263; credit or registration in Mining Engineering 356.

396. **Seminar.** Review of mining and petroleum literature; reports; technical writing. ¼ unit.

Metallurgical Engineering

COURSES FOR GRADUATES

405. **Advanced Physics of Metals.** Introduction to quantum mechanics, theory and experiment, potential barrier problem, hydrogen atom, perturbation theories, application to the study of solids. 1 unit. Prerequisite: Mathematics 343 and 345; Physics 381 or 383; Metallurgical Engineering 318; or consent of instructor.

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. 1 unit. Prerequisite: Metallurgical Engineering 405, or Physics 385, or consent of instructor.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. 1 unit. Prerequisite. Consent of instructor.

408. **Dislocations and Mechanical Properties of Metals.** General static and dynamic properties of single dislocations in crystals; dislocation interactions; properties of dislocation arrays; role of dislocations in metallurgical phenomena with particular emphasis on mechanical properties. 1 unit. Prerequisite: Consent of instructor.

409. **Crystal Physics.** The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction and diffusion, thermoelectricity, deformation, elasticity, and martensitic transformations. The effects of crystal symmetry and the properties of aggregates are discussed. 1 unit. Prerequisite: Vector algebra, determinants, and thermodynamics; consent of instructor.

410. **Advanced X-Ray Metallography.** X-ray diffraction as applied to the study of metals and alloys; effects of cold work, annealing, substructures, preferred orientation and ordering, principles of electron and neutron diffraction. 1 unit. Prerequisite: Chemistry 427 or consent of instructor.

420. **Metallurgical Thermodynamics.** Fundamental thermodynamic considerations and applications of thermodynamics to metallurgical problems; particular emphasis on heterogeneous equilibrium and thermodynamic properties of solutions; topics approached from the viewpoints of both macroscopic thermodynamics and statistical mechanics. 1 unit. Prerequisite: Metallurgical Engineering 314 or equivalent.

421. **Kinetics of Phase Changes in Metals.** The viewpoint of statistical thermodynamics, rate theory, diffusion in solids, interface energy, nucleation theories, phenomenological analysis of nucleation and growth; application to crystal growth, diffusionless phase changes, oxidation, pearlite reaction, precipitation, sintering. 1 unit. Prerequisite: Metallurgical Engineering 420 or consent of instructor.

485. **Metallurgical Engineering Problems.** Individual study in areas of metallurgical engineering not covered by regular course offerings, carried out under

the supervision of a member of the staff. ½ to 2 units. Prerequisite: Consent of instructor.

493. **Seminar in Anelasticity.** Lectures and discussions of the nature of anelasticity and its application to metallurgy. 0 or ¼ unit. Prerequisite: Consent of instructor.

494. **Seminar on Phase Transformations in Metals.** Discussion of current research in this field including presentation by graduate students of their own work. 0 or ¼ unit. Prerequisite: Consent of instructor.

495. **Seminar on Diffusion and Imperfections.** Lectures and discussions on diffusion and imperfections in crystalline solids. 0 or ¼ unit. Prerequisite: Consent of instructor.

497. **Seminar on Alloy Phases.** Discussion and lectures on current research, including work by the graduate students themselves, relating to the electronic structure and crystal structure of alloy phases. 0 or ¼ unit. Prerequisite: Consent of instructor.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical research in other laboratories by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. No credit.

499. **Thesis Research.** Individual research in specialized problems under the supervision of members of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Metallurgy of Welding.** Heat flow and thermal cycles in welding and cutting of metals; physical metallurgy and mechanical properties of weld metal and thermally altered base metal; joining methods in relation to composition, microstructure, and mechanical properties; specifications, economics, and service requirements. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 or equivalent.

302. **Powder Metallurgy.** Production and testing of powdered metals; fabrication and application of metal shapes produced from powdered metals. ½ or ¾ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304.

304. **Powder Metallurgy Laboratory.** Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302.

306. **Design of Engineering Alloys.** A study of the fundamental principles which determine the constitution, structure, treatment, and application of alloy steels and other special-purpose high-performance alloys. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 and 311.

307. **Corrosion of Metals.** Electrochemistry, thermodynamics, and kinetics of corrosion; behavior of ferrous and nonferrous metals; corrosion rates; corrosion control, cathodic and anodic protection; high-temperature corrosion; corrosion testing; electrolytic machining methods. ¾ or 1 unit. Prerequisite: Mechanical Engineering 234 or equivalent.

310. **X-Ray Metallography.** X-ray generation and scattering with applications to problems in physical metallurgy, such as phase identification, the determination of solid solubility, the measurement of grain size and preferred orientation, and other topics. ¾ unit. Prerequisite: Physics 108.

311. **Advanced Phase Diagrams.** Interpretation of multicomponent phase diagrams for metal systems. ½ unit. Prerequisite: Metallurgical Engineering 201 or equivalent.

314. **Metallurgical Thermodynamics.** Thermodynamic principles are applied to the study of phase and chemical equilibrium and to the calculation of free energy of phases. ¾ unit. Prerequisite: Credit or registration in Chemistry 246.

315. **Metallurgical Kinetics.** Diffusion and heat flow calculations and their applications to kinetics of metallurgical processes. ¾ unit. Prerequisite: Metallurgical Engineering 208 and 314.

316. **Mechanical Metallurgy.** Fundamentals of plastic deformation of metals; theory and techniques of rolling, deep drawing, extrusion, and rod and wire drawing; metallurgical defects and difficulties encountered in metal forming. ¾ unit. Prerequisite: Senior standing in metallurgical engineering or consent of instructor.

318. **Physics of Metals.** The nature of the perfect and imperfect crystal, the electronic structure of solids, electrical conduction in metals and semiconductors, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Senior standing in engineering, or consent of instructor.

384. **Properties of Solids.** Perfect and imperfect crystal lattices, electronic structure of solids including basic theory and applications to transport properties of metals and semi-conductors, semi-conductor diodes; dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

385. **Structural Physical Metallurgy.** A comprehensive survey of selected areas of structural physical metallurgy, excluding electronic processes. Not open to graduate students with an undergraduate major in metallurgy. ¾ unit. Prerequisite: Physical chemistry or classical thermodynamics, differential equations, and consent of instructor.

Petroleum Engineering

COURSES FOR GRADUATES

420. **Porous Media Hydromechanics.** Introduction to theoretical hydromechanics. Classification of fluids, fundamental laws and basic equations of motion applicable to microscopic and macroscopic regimes; treatment of interfacial forces and surfaces in multi-phase flow as particularly applied to porous media systems. ¾ or 1 unit. Prerequisite: Mathematics 343, Petroleum Engineering 373, or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

371. **Reservoir Mechanics, I.** The mechanics of the movement of fluids in the porous rock reservoirs of the subsurface, especially as related to questions dealing with the production and storage of petroleum fluids, ground water, and natural gases. 1 unit. Prerequisite: Mathematics 345, Theoretical and Applied Mechanics 235.

372. **Reservoir Mechanics, II.** A continuation of Reservoir Mechanics, I, showing the application of the fundamental concepts in developing procedures for forecasting the future performance of reservoir systems as derived from a knowledge of initial and boundary conditions, and as derived with reference to the past history of fluid movement and displacement. 1 unit. Prerequisite: Petroleum Engineering 371.

373. **Advanced Reservoir Engineering.** Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. ¾ or 1 unit. Prerequisite: Mathematics 345, Petroleum Engineering 372, or consent of instructor.

MUSIC

The School of Music offers the Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Master of Music. The major field may be in musicology, music theory and composition, or performance and literature (organ, voice, piano, violin, viola, cello, solo wind instruments, and percussion instruments).

The admission requirement, in terms of grade-point average, is at least 3.5. In addition, an applicant is required: (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or its equivalent, at the University of Illinois or another accredited institution; and (2) to pass a qualifying examination in the major field of concentration. If the major is to be performance and literature, this examination is essentially one of performance on the major instrument. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of German or French is required. Candidates in voice should have had one year each of French, German, and Italian, unless two years of one language have been completed in high school. All prospective candidates for the Master of Music must take a placement examination in the history of music and the theory of music.

Doctor of Musical Arts. The fields of specialization for this degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree programs comprise the following major areas: composition, choral music, piano, organ, violin, viola, cello, voice, and wind instruments.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. The prerequisites for admission are as follows:

(1) The Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units;

(b) Major in Performance and Literature: performance and literature, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) A high level of proficiency in composition or performance.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, psychology, and philosophy. Students lacking an appropriate background in liberal arts and sciences may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination.

(5) Successful completion of qualifying examinations. These examinations in performance and literature, the history of music, and the theory of music must be taken within the first two or three weeks of the first semester or summer session in residence. Prospective applicants should write to 100 Smith Music Hall for complete information concerning the nature of these examinations.

If the candidate fails to pass the qualifying examinations, he must repeat all

or parts of them no later than the end of the second semester in residence. Until the examinations have been passed, the student is considered to have a provisional status.

After admission to the doctoral program the student must fufill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, calendar, grades, and major and minor fields.

A minimum of sixteen units of graduate credit beyond the eight units required for the Master of Music is necessary to earn the Doctor of Musical Arts. In the fields of composition, and performance and literature, three units are devoted to the completion of a special doctoral project: for the former, the writing of an original score on a large scale; for the latter, the study of a comprehensive repertory and either two solo recitals, or one solo recital and two of the following options: (1) a concerto performance; (2) the perfomance of a major role in an opera or oratorio; 3) a chamber music program; (4) a lecture recital: (5) a coaching performance of an instrumental or vocal ensemble. Two units are devoted to the completion of an original thesis. In the field of choral music, one unit is devoted to a doctoral project involving the preparation and presentation of a choral program of approximately one hour in length selected from a comprehensive repertory. Four units are devoted to the completion of an original thesis.

In addition to the foregoing, the work includes the following required courses: composition or performance and literature, three units; Music 420, Seminar in Music Literature for Doctoral Candidates, two units. One unit of work must be taken in the field of education or music education unless the candidate has previously passed equivalent course work. At least two, but no more than four, units are devoted to an outside minor field.

Three of the six units of electives must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College.

Doctor of Philosophy in Musicology. The Doctor of Philosophy in Musicology is intended for applicants whose interests lie in research in the history of music, theory of music, psychology of music, ethnomusicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see pages 18 to 25), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the Master of Music with a major in musicology or theory of music; (2) have acquired a background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, psychology, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the sixteen units must be in Music 499 and are devoted to the completion of an original doctoral thesis. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or the equivalent, in courses including Music 320, 322, 414, 415, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in performance.

(2) A minimum of two units in one or two minor fields.

(3) In addition to the general foreign language requirements of the Graduate College, proficiency in Latin is expected. An examination in one or more addi-

tional foreign languages may be required when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(4) A preliminary examination administered by a committee appointed by the Dean of the Graduate College.

Master of Science in Music Education. Candidates for this degree must earn four units in music, two units in education, and two units in electives. Requirements are four units of music; two courses from History and Philosophy of Education 301, 302, 303, 304, one unit; Educational Psychology 311 and 312, one unit; and electives, two units. The electives may be in music, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy placement examinations in music history, music theory, and performance and literature in the principal music area.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music theory and applied music.

Residence. At least four units must be earned in residence on the Urbana campus. This requirement may be met by spending one full semester or two eight-week summer sessions in residence.

Program. A minimum of eight units beyond the master's degree is required. Music 440 and 441 and either Educational Psychology 411 or 412 are required. The remainder of the program is based upon the student's needs and interest and upon the deficiences revealed in placement tests. No more than one unit of performance and literature may be counted toward the certificate.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Doctor of Education. The program leading to the Doctor of Education with a major in music education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations are administered by the School of Music in music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a mini-

mum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. At least sixteen units of work beyond the master's degree are required, including six units in music courses and six units in education courses. No more than one unit of credit in performance and literature may be counted toward the degree.

The following courses are required: History and Philosophy of Education 410, Educational Psychology 415; Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. For work completed elsewhere, see page 20. Extramural course work may not be included as part of this sixteen-unit requirement.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

GRADUATE FACULTY

Professors: D. A. Branigan (Director of School of Music), B. Bergethon, G. W. Binkerd, Dorothy E. Bowen, H. Decker, S. Fletcher, B. R. Foote, J. C. Garvey, S. Goldthwaite, B. M. Goodman, C. E. Hamm, M. H. Hindsley, G H. Hunter, J. R. Kelly, H. Kessler, Colleen J. Kirk, E. D. Kisinger, C. Leonhard, A. J. McDowell, P. S. Pettinga, Claire L. Richards, A. L. Ringer, P. Rolland, H. Schmitt, H. Sexton, S. Stravinsky, R. Swenson, P. Ulanowsky, G. R. Waller, Grace E. Wilson, Velma Wilson, L. E. Zirner.

Associate Professors: J. L. Bailey, E. S. Berry, A. M. Carter, Dorothy E. Clark, W. R. Coggins, C. DeLaney, P. S. Farrell, L. T. Fredrickson, K. L. Gaburo, R. E. Gray, R. J. Hamilton, L. A. Hiller, T. L. Holden, B. Johnston, H. Karp, K. Kellogg, C. J. Kleinsteuber, E. J. Krolick, J. H. McKenzie, W. H. Miller, P. Painter, D. W. Sanders, R. E. Thomas.

Assistant Professors: R. J. Colwell, B. E. Edlefsen, R. B. MacDonald, Evelyn Reynolds, R. B. Smith.

Visiting Lecturers: A. Hughes, B. Nettl.

COURSES FOR GRADUATES

400. Advanced Instrumentation: Chamber and Symphonic. Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. Advanced Instrumentation: Band. Arrange for the concert band, works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. Analysis in Relation to Performance and Interpretation, I. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. Leonhard.

403. Analysis in Relation to Performance and Interpretation, II. A unifying course in the structure of music, to which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. 1 unit. Prerequisite: Music 402. Leonhard.

406. **Composition.** Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. ½ to 1½ units. COMPOSITION FACULTY.

410. **History of Music Theory, I.** The development of theoretical concepts from antiquity through the Renaissance; a study of selected theoretical treatises written before 1550. 1 unit. Prerequisite: Graduate standing in musicology or composition or consent of instructor. HUGHES.

411. **History of Music Theory, II.** The development of theoretical concepts from the High Renaissance to the present; a study of selected treatises from 1550 to the present. 1 unit. Prerequisite: Graduate standing in musicology or composition, or consent of instructor. HUGHES.

412. **History of Musical Aesthetics, I.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles. From Pythagoreanism to the humanistic period. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Graduate standing in music. RINGER.

413. **History of Musical Aesthetics, II.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles. From the seventeenth century to the present day. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Music 412. RINGER.

414. **Notation, I.** The history of notation from its beginning to 1400. ½ unit. Prerequisite: Consent of instructor. GOLDTHWAITE.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. ½ unit. Prerequisite: Music 414 or consent of instructor. GOLDTHWAITE.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Music 312 or consent of instructor. GOLDTHHWAITE.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Music 416 or consent of instructor. GOLDTHWAITE.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory, and aesthetics of opera. The principal composers covered are Monteverdi, Cavilli, Cesti, Lully, Rameau, Blow, Purcell Scarlatti Handel, Gluck. ½ or 1 unit. Prerequisite: Music 312 or consent of instructor. HAMM.

419. **The History of Opera from Mozart to the Present.** A detailed examination of stylistic and structural developments in opera after Gluck with special reference to representative works from Mozart to Schoenberg viewed in relation to the general musical and cultural background of their time and place of origin. ½ or 1 unit. Prerequisite: Music 312 and 313 or consent of instructor. RINGER.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students (except those in choral music) enrolled in the Doctor of Musical Arts program. 1 unit; maximum accumulated credit, two units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. **Seminar in Music Education.** An introduction to problems and methods of research in music education. Required of all candidates for the Doctor of Education in music education. 1 unit. Prerequisite: Graduate standing in music education or consent of instructor. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields

of music theory, history of theory, and history of musical materials. ½ or 1 unit. Prerequisite: Graduate standing in music theory or consent of instructor. KESSLER.

423. **Seminar in Musicology.** Problems in historical and systematic musicology. Discussions of special problems and reports on individual research. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. HAMM, RINGER.

424. **Bach, I.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music.

425. **Bach, II.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music.

426. **Beethoven, I.** ½ or 1 unit. Offered in 1965-1966 and in alternate years. KESSLER.

427. **Beethoven, II.** ½ or 1 unit. Offered in 1965-1966 and in alternate years. KESSLER.

428. **Problems and Methods.** An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports of bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. 1 unit. SIEBERT.

430. **Advanced Orchestra Conducting and Literature.** Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestras. 1 unit. Prerequisite: Previous conducting experience. GOODMAN.

431. **Advanced Band Conducting and Literature.** Study of problems and techniques of band conducting and a survey of literature for the concert band. 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Techniques.** An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. **Advanced Choral Literature and Conducting.** An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. 1 unit. Prerequisite: Graduate standing in music education, Music 432 or equivalent, or consent of instructor. DECKER.

434. **Piano Literature.** 1 unit; maximum accumulated credit, two units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. KESSLER.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. 1 unit; maximum accumulated credit, two units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. KELLOGG.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, two units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. PETTINGA.

437. **String Instrument Literature.** 1 unit; maximum accumulated credit, two

units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. FARRELL.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, two units. EDLEFSEN, KISINGER.

439. **Percussion Instruments Literature.** An integrating course, offering the opportunity to survey and analyze the field of solo and ensemble percussion literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit. Students may register twice for a total credit of two units. Prerequisite: Graduate standing in the School of Music; consent of instructor. MCKENZIE.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. ½ or 1 unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

444. **The General Music Program in Elementary Schools.** A detailed consideration of elementary general music, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. **Seminar and Laboratory in Musical Acoustics, I.** Special topics in acoustics including formant theory and communication theory. Application of electrical and electronic techniques to music reproduction and propagation; audio-visual aids. ½ or 1 unit. Prerequisite: Graduate standing in music or music education, or consent of instructor. HILLER.

447. **Seminar and Laboratory in Musical Acoustics, II.** Techniques of modern experimental electronic music; related music theory; computational music and related topics. Individual projects for selected students. ½ or 1 unit. Prerequisite: Music 446 or consent of instructor. HILLER.

450. **History of Vocal Ensemble and Choral Music, I.** A critical and analytic study of vocal and choral ensemble music from the Middle Ages to 1750. 1 unit; S, ½ unit. HAMM.

451. **History of Vocal Ensemble and Choral Music, II.** A critical and analytic study of vocal and choral ensemble music from 1750 to the present. 1 unit; S, ½ unit. HAMM.

480. **Piano.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

481. **Voice.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

482. **Organ.** Selected studies from the masterworks of organ literature. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

483. **String Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

484. **Wind Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

485. **Percussion Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

489. **Doctoral Projects.** Special projects for candidates for the Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. 1 to 3 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

499. **Thesis Research.** Research in special projects. 0 to 4 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Eighteenth-Century Counterpoint.** The study of the technique of contrapuntal writing as found in the works of J. S. Bach and other eighteenth-century composers. Imitation, canon, invertible counterpoint, two- and three-part inventions, etc., are studied through writing and analysis of compositions by eighteenth-century composers. ½ unit. Prerequisite: Music 104 and/or consent of instructor. BINKERD, FREDRICKSON.

301. **Fugue.** The study of fugal writing during the eighteenth and early nineteenth centuries. A continuation of the study of tonal counterpoint begun in Music 300, with special emphasis on the study and analysis of the fugal works of J. S. Bach, Handel, and Beethoven and on the writing of fugues and part fugues. ½ unit. Prerequisite: Music 300 and/or consent of instructor. BINKERD, FREDRICKSON.

302. **Musical Acoustics, I.** A survey of basic topics in the physics of music: wave motion and the physical properties of sound; the ear and hearing; timbre, formant theory, and the acoustical properties of musical instruments. ½ unit. Prerequisite: Consent of instructor. HILLER.

303. **Musical Acoustics, II.** Acoustics, mathematics, aesthetics of pitch organization in music; scales, tuning, and temperament; pitch and rhythm, and their structural interrelationships; theories of perception of pitch and rhythm. ½ unit. Prerequisite: Music 302 and/or consent of instructor. JOHNSTON.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used and includes the study of form and harmony as these bear on the problems. ½ unit. Prerequisite: Music 104 or consent of instructor. THOMAS.

305. **Analytical Techniques, II.** Continuation of Music 304, beginning with the early seventeenth century and coming down to the present day. ½ unit. Prerequisite: Music 304 or consent of instructor. THOMAS.

306. **Composition.** Work in original composition including the small and large

homophonic forms. ½ or 1 unit. Prerequisite: Music 104 or 106, or consent of instructor. COMPOSITION FACULTY.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. ½ unit. Prerequisite: Consent of instructor. BINKERD.

308. **Counterpoint of the Fifteeenth and Sixteenth Centuries.** Continuation of Music 307. ½ unit. Prerequisite: Music 307. BINKERD.

309. **Seminar in Music for Dance.** Theory and practice of combining sound and movement in theatrical dance. Individual projects providing experience in collaboration for both composers and choreographers. ½ unit. Prerequisite: Music 106, 306, or Dance 265 and/or consent of instructor.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. ½ unit. Prerequisite: Music 131 or 214 or consent of instructor. HUGHES.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. ½ unit. Prerequisite: Music 131 or 214 or consent of instructor. HUGHES.

312. **Music of the Baroque and Classical Periods.** A history of music from about 1600 to 1800. ½ unit. Prerequisite: Music 131 or 214 or consent of instructor. HANSELL.

313. **Music of the Nineteenth and Twentieth Centuries.** A history of music from about 1800 to the present. ½ unit. Prerequisite: Music 131 or 214 or consent of instructor. RINGER.

314. **History of Musical Instruments.** The evolution of instruments, both Western and non-Western, considered in their social and cultural settings; construction and playing techniques of instruments treated in relation to performance practice and stylistic developments. ½ unit. Prerequisite: Music 213 and 214 or consent of instructor. NETTL.

315. **Contemporary Music.** A survey of all important trends, forms, and styles of modern music from 1875 to the present. ½ unit. Prerequisite: Consent of instructor. MACDONALD, RINGER.

316. **Musical Cultures of the World, I.** A survey of music outside the realm of Western art music. Formal and stylistic issues are treated within their social context and in relation to general culture patterns. For music majors and other qualified students. ½ unit. Prerequisite: For students outside the School of Music, consent of instructor. NETTL.

317. **Musical Cultures of the World, II.** A survey of music outside the realm of Western art music. Formal and stylistic issues are treated within their social context and in relation to general culture patterns. For music majors and other qualified students. ½ unit. Prerequisite: Music 316 or consent of instructor. NETTL.

318. **History of Performance Practices, I.** The study of musical performance from about 900 to 1600. Discussion of musical instruments, makeup of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. **History of Performance Practices, II** The study of musical performance from 1600 to 1750. Discussion of musical instruments, ornmentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. **Proseminar.** Provides special preparation in specialized fields of musicology, music education, theory, and composition. ½ or 1 unit; maximum accumulated credit, two units. Prerequisite: Senior or graduate standing in music or music education and consent of instructor. STAFF.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music, or consent of instructor. HAMM.

323. **Opera Production, I.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 265 and 381; consent of instructor. ZIRNER.

324. **Opera Production, II.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 323. ZIRNER.

330. **Applied Music Pedagogy.** A survey of techniques, practices, and materials. Presentation of group and individual instruction. An approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. ½ unit; maximum accumulated credit, 1 unit. Prerequisite: Consent of instructor. FLETCHER, MILLER, ROLLAND.

332. **Church Music Literature.** A survey of the development of church music with emphasis on the period since 1500. ½ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Music 214 or 311, or consent of instructor. HAMILTON.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. ½ unit. Prerequisite: Music 332 or consent of instructor. HAMILTON.

334. **The Music of America, I.** A study of folk, popular, and art music in America from the time of the first European settlers through the middle of the nineteenth century. Psalmody, early opera and concert life, African and European folk music, the singing school, music of European immigrants, and the roots of jazz. ½ unit. Prerequisite: Senior standing in music or consent of instructor. HAMM.

335. **The Music of America, II.** A study of chamber, choral, and orchestral music written by American composers from 1850 to the present; jazz and its offshoots; folk and popular music, and experimental music in America. ½ unit. Prerequisite: Senior standing in music or consent of instructor. HAMM.

340. **Instrumental Clinic and Band Pageantry.** A study of the peculiarities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing, charting and show continuity, marching fundamentals, and special problems. ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

341. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

342. **Percussion Methods.** Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. ½ unit. Prerequisite: Senior or graduate standing in music education, and Music 174 and 257 or equivalent. MCKENZIE.

344. **Methods of String Class Teaching.** Designed primarily for teachers of school

music who are not performers on a string instrument, yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Senior or graduate standing in music education or consent of instructor. WALLER.

345. **Teaching Techniques of Music Theory.** Teaching materials, methods, texts, and pedagogical sequence are discussed and analyzed, including an intensive survey of the structural materials normally covered during the first two years of collegiate study. ½ unit. Prerequisite: Music 300 or consent of instructor.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit; maximum accumulated credit, two units. Prerequisite: Senior or graduate standing in music education or consent of instructor. BERGETHON, LEONHARD.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1966 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. MCDOWELL.

348. **Teaching of Brass Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1965 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. SEXTON.

349. **Music in Early Childhood.** A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. ½ unit. Prerequisite: Senior or graduate standing in music education or child development. SMITH.

350. **Advanced Ensemble Music.** Selected projects in the study and performance of ensemble literature including the areas of operatic, instrumental, and vocal-choral literature and accompanying. ½ unit; S, ¼ unit. Prerequisite: Registration in applied music at the 300 level; consent of instructor. GARVEY, HUNTER, SWENSON, ZIRNER.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

380. **Piano.** ½ or 1 unit; S, ¼ or ½ unit. BILSON, FLETCHER, KARP, RICHARDS, SANDERS, STRAVINSKY, ZIRNER.

381. **Voice.** ½ or 1 unit; S, ¼ or ½ unit. BAILEY, BOWEN, CLARK, FOOTE, KELLOGG, MILLER, REYNOLDS, WILSON.

382. **Organ.** ½ or 1 unit; S, ¼ or ½ unit. HAMILTON, PETTINGA.

383. **Violin.** ½ or 1 unit; S, ¼ or ½ unit. ROLLAND, SCHMITT.

384. **Viola.** ½ or 1 unit; S, ¼ or ½ unit. GARVEY.

385. **Cello.** ½ or 1 unit; S, ¼ or ½ unit. FARRELL, SWENSON.

386. **String Bass.** ½ or 1 unit; S, ¼ or ½ unit. KROLICK.

387. **Flute.** ½ or 1 unit; S, ¼ or ½ unit. DELANEY.

388. **Clarinet.** ½ or 1 unit; S, ¼ or ½ unit. COGGINS, MCDOWELL.

389. Oboe. ½ or 1 unit; S, ¼ or ½ unit. EDLEFSEN.

390. Bassoon. ½ or 1 unit; S, ¼ or ½ unit. BERRY.

391. Cornet and Trumpet. ½ or 1 unit; S, ¼ or ½ unit. SEXTON.

392. French Horn. ½ or 1 unit; S, ¼ or ½ unit. HOLDEN.

393. Trombone. ½ or 1 unit; S, ¼ or ½ unit. GRAY.

394. Baritone. ½ or 1 unit; S, ¼ or ½ unit. GRAY.

395. Tuba. ½ or 1 unit; S, ¼ or ½ unit. GRAY.

396. Percussion. ½ or 1 unit; S, ¼ or ½ unit. MCKENZIE.

397. Harp. ½ or 1 unit; S, ¼ or ½ unit. KLEINSTEUBER.

398. Saxophone. ½ or 1 unit; S, ¼ or ½ unit. COGGINS.

399. Harpsichord. ½ or 1 unit; S, ¼ or ½ unit. HUNTER.

NUCLEAR ENGINEERING

The interdepartmental committee on nuclear engineering offers work leading to the Master of Science and Doctor of Philosophy in Nuclear Engineering and provides courses and research facilities for doctoral candidates in nuclear engineering and related fields.

The programs in nuclear engineering are open to all graduates in engineering, mathematics, and the physical sciences who have a grade-point average of at least 4.0 out of 5.0 for the last two years of undergraduate work. Students with grade-point averages below 4.0 but above 3.5 are considered individually. Applicants who fall in this latter category are invited to support their applications with a letter explaining the circumstances. It is recommended that they also submit letters of reference and information as to their rank in class.

Undergraduate courses in differential equations, advanced calculus, atomic physics, and nuclear physics are required as background for the nuclear engineering program. A student may be admitted before he has completed these four prerequisites, but he must then allow an additional semester or summer of study for completion of the master's degree. Other recommended undergraduate preparation includes additional mathematics, thermodynamics and heat transfer, continuum mechanics, physical metallurgy, solid state physics, and electronics.

The general requirements of the Graduate College must be met for either degree. Specific requirements for the degrees in nuclear engineering are as follows:

(1) The master's degree requires eight units including a thesis, or nine units without a thesis. At least four of these units must be in nuclear engineering courses. The remaining courses are electives which must be approved by the candidate's adviser.

(2) Excluding the thesis requirement, a candidate for the doctor's degree must complete a minimum of sixteen units of graduate work. Six of these units must be in nuclear engineering. An integrated group of at least four units of graduate courses in an established engineering discipline or in one of the physical sciences is strongly recommended.

A 250-kilowatt TRIGA Mark II reactor is located on campus for research and teaching in nuclear engineering. The reactor can be pulsed to power levels of 1000 megawatts for special studies. Teaching facilities include a nuclear metallurgy laboratory, a radiochemistry and nuclear instrumentation laboratory, a boiling water heat transfer loop, several subcritical natural uranium assemblies, a waste disposal laboratory, and a direct energy conversion laboratory.

For further information see the booklet *Graduate Program in Nuclear Engineering*, available from the Nuclear Engineering Office, 214 Nuclear Engineering Laboratory.

GRADUATE FACULTY

Professors: R. J. Martin (Chairman of Nuclear Engineering Committee), F. T. Adler, A. W. Allen, R. W. Bohl, A. P. Boresi, B. T. Chao, B. B Ewing, L. Goldstein, J. S. Koehler, R. F. Larson, M. S. McVay, J. E. Pearson, M. E. Wyman.

Associate Professors: A. B. Chilton, G. A. Costello, D. F. Hang, J. P. Hummel, G. H. Miley.

Assistant Professors: J. L. Brownlee, Jr., J. G. Kay, K. Preiss.

Instructor: B. G. Jones.

COURSES FOR GRADUATES

401. **Fundamentals of Nuclear Engineering.** A lecture and problem course to provide background for further work in nuclear engineering. Problems in materials, heat transfer, and fluid flow. Special emphasis is given to basic ideas and the mathematical similarity of problems in heat transfer, fluid flow, and neutron diffusion. 1 unit. Prerequisite: Physics 282 or 382 and Mathematics 345, or equivalent, or consent of instructor.

421. **Nuclear Concepts.** Selected topics in low-energy nuclear physics of general interest to the nuclear engineering field. Nuclear reactions, cross sections, slowing down and interactions with matter, decay theory, and nuclear forces. 1 unit. Prerequisite: Physics 282 or 382; consent of instructor.

431. **Nuclear Metallurgy.** Metallurgical principles applied to materials problems in nuclear engineering, including topics in production of uranium, corrosion, radiation damage, fuel element fabrication, and fuel reprocessing. 1 unit. Prerequisite: Consent of instructor.

441. **Nuclear Radiation Shielding.** Radiation units and measurement; tolerance limits; interaction of radiation and matter; geometry factors in attenuation; gamma ray and neutron attenuation; moment theory for attenuation; application to reactors, protective shelters, and space vehicles. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

447. **Radioactive Waste Disposal.** Same as Civil Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous waste disposal; air monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282 or Nuclear Engineering 398 (Chemistry 398) or consent of instructor.

451. **Reactor Laboratory.** Reactor operation: start-up, changes in power level, and shutdown. Reactor instrumentation; subcritical assemblies; flux measurements in core and thermal column; control rod worth measurements; effects of changes in fuel configurations; activation and neutron beam experiments. ½ or 1 unit. Prerequisite: Consent of instructor.

454. **Nuclear Engineering Laboratory Investigations.** Individual laboratory investigations in nuclear engineering. ½ to 1½ units. Prerequisite: Consent of instructor.

455. **Reactor Physics, I.** Same as Physics 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections; diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Mathematics 343 and 345, Nuclear Engineering 347, or consent of instructor.

456. **Reactor Physics, II.** Same as Physics 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Nuclear Engineering 455 or consent of instructor.

458. **Nuclear Reactor Engineering.** Development of engineering design phases of the fission chain reactor: reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. 1 unit. Prerequisite: Consent of instructor.

460. **Reactor Kinetics.** Discussion of special topics such as response of reactor systems to changes of power demand and reactivity. Transfer function analysis, nonlinear problems of reactor dynamics, reactor stability; fuel cycles; digital and analog computer methods for solving reactor kinetic problems. 1 unit. Prerequisite: Nuclear Engineering 401 and 455, or consent of instructor.

467. **Thermomechanics of Nuclear Reactor Systems.** Same as Theoretical and Applied Mechanics 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal-shock and thermal stress-wave propagation; current thermomechanics problems in nuclear reactor design; term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

490. **Special Topics.** Selected areas are considered which are of current interest in research, such as nuclear materials, advanced reactor systems, thermonuclear problems, digital computer methods in nuclear engineering, advanced topics in reactor theory. ½ or 1 unit. Prerequisite: Consent of instructor.

495. **Nuclear Engineering Problems.** Individual study in areas of nuclear engineering and closely related fields not covered by regular course offerings. The work is carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: At least three units of graduate work; consent of instructor.

497. **Seminar in Nuclear Science and Engineering.** Lectures and discussions on current work in research and development in nuclear engineering and related fields by staff, advanced students, and visiting lecturers. 0 or ¼ unit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

347. **Introduction to Nuclear Engineering.** Nuclear particles and nuclear chain reactions, energy release from fission; classification of nuclear reactors; fast and thermal reactors; reactor theory; slowing down and diffusion of neutrons; radiation shielding; materials of construction, radiation damage; reactor instrumentation, safety, and control; chemical processing of nuclear materials. ¾ or 1 unit. Prerequisite: Physics 282 or 382 and senior standing in engineering, or consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Civil Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry; sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Nuclear Engineering 397 or Physics 382 or equivalent.

397. **Radiochemistry.** Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applica-

tions of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Chemistry 398. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. One laboratory and one discussion period per week. ½ unit. Prerequisite: One semester of physical chemistry or consent of instructor.

PHILOSOPHY

The Department of Philosophy offers work leading to the Master of Arts and Doctor of Philosophy.

Students beginning graduate work with philosophy as their major subject are expected to have a grade-point average of at least 4.0 for the last sixty hours of work completed. Applications of students whose grade-point averages are below 4.0 but above 3.75 are considered on an individual basis, as are also all applications for entrance with advanced standing.

In addition, students applying for admission in philosophy should have had courses in logic, ethics, history of philosophy, and theory of knowledge. Students with deficiencies are required to take one or more of the following courses: Philosophy 102 (or 333), 321, 303, 306, or 330, in addition to meeting the minimum requirements of eight units for the master's degree.

Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic, philosophy of science, and philosophy of language; and theory of value, including ethics, aesthetics, social philosophy, and philosophy of religion. In addition to completing eight units of graduate work, the candidate must take an oral examination on the work represented by these units, including his master's thesis.

Doctor of Philosophy. A candidate carries on (1) major studies in one of three fields within the department; (2) minor studies amounting to at least two units in each of the two remaining fields; and (3) minor studies amounting to at least two units in a department other than philosophy. The candidate's choice of major and minors must be approved by the department.

The candidate must pass a preliminary examination, write a dissertation of publishable quality, and pass a final examination on the dissertation.

A detailed statement of the special departmental requirements for graduate students can be obtained from the Department of Philosophy, 105 Gregory Hall.

GRADUATE FACULTY

Professors: B. J. Diggs (Chairman of Department), M. H. Fisch, D. W. Gotshalk, L. Linsky, A. R. Turquette, F. L. Will.

Associate Professors: J. Agassi, O. A. Kubitz, H. M. Tiebout.

Assistant Professors: C. E. Caton, N. Kretzmann, W. J. Wainwright, J. D. Wallace.

Instructors: J. Brock, H. S. Chandler, B. Goldberg, R. Swartz, J. Zartman.

COURSES FOR GRADUATES

401. **Seminar in Ancient Philosophy.** 1 unit. May be repeated for credit.

403. **Seminar in Medieval Philosophy.** 1 unit. Diggs, Kretzmann.

405. **Seventeenth-Century Continental Thought (Descartes, Spinoza, Leibnitz).** A study of the basic philosophical works of the three leading continental thinkers of the century. 1 unit.

407. **British Empiricism.** 1 unit. Turquette.

408. **German Idealism (Kant).** 1 unit. GOTSHALK.

409. **Recent American Philosophy.** Major American philosophers and movements since about 1900. Reports and discussions. 1 unit. FISCH.

411. **Seminar in Recent Ethical Theory.** 1 unit. May be repeated for a maximum of two units. DIGGS, FISCH.

412. **Seminar in Social Philosophy.** A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. Students may receive credit more than once. 1 unit. DIGGS.

413. **Logical Theory.** 1 unit. Prerequisite. A course in logic or consent of instructor. TURQUETTE.

415. **Seminar in Metaphysics.** Intensive study of a selected topic of major importance in the field of metaphysics. May be repeated for credit. 1 unit.

417. **Philosophy and Methods of Science.** Various problems arising from specific studies in philosophy pertaining to science and vice versa; it is expected that each semester the members of the seminar will select one or two such topics. 1 unit.

420. **Seminar in Semantics.** Same as Communications 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. LINSKY.

421. **Seminar in Contemporary Problems.** Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

422. **Seminar in Contemporary Problems.** Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

423. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. WILL.

424. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. WILL.

430. **Seminar in Modern Aesthetics.** 1 unit. GOTSHALK.

483. **Individual Topics.** Individual study and oral and written reports on topics not covered in other courses. Not more than one unit may be counted toward the A.M. degree and not more than two toward the Ph.D. degree. Topics and plan of study must be approved by the candidate's adviser and by the staff member who directs the work. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** 1 unit. FISCH.

304. **History of Medieval Philosophy.** Lectures and reading in the history of philosophy from St. Augustine to William of Ockham. ¾ or 1 unit. Prerequisite: Philosophy 101 or 303. DIGGS, KRETZMANN.

306. **History of Modern Philosophy.** 1 unit. GOTSHALK.

307. **History of Modern Philosophy.** Bacon, Hobbes, Locke, Berkeley, Hume. S; ½ unit. Prerequisite: Consent of instructor.

308. **History of Modern Philosophy.** Descartes, Spinoza, Leibnitz, Kant. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

309. **The Philosophy of Plato.** ¾ or 1 unit. Prerequisite: Philosophy 101 or 303.

311. **Philosophic Ideas of the Nineteenth and Twentieth Centuries.** ¾ or 1 unit. KRETZMANN, TIEBOUT.

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. ¾ or 1 unit. Prerequisite: One course in philosophy. FISCH.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. ¾ or 1 unit. Prerequisite: One course in philosophy. WALLACE.

319. **Philosophical Ideas in Latin America.** A survey of the main philosophical currents and thinkers of Latin America. ½ or 1 unit. Prerequisite: One course in philosophy. KUBITZ.

321. **Ethics and Value Theory.** ¾ or 1 unit. Prerequisite: One course in philosophy. CATON, DIGGS.

322. **Recent Developments in Ethics.** Ethical theories of the last fifty years: intuitionism, naturalism, pragmatism, emotivism, existentialism, analytic ethics. ¾ or 1 unit. Prerequisite: Philosophy 103, 105, or 321.

323. **Philosophy of Art.** A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. ¾ or 1 unit. GOTSHALK.

324. **Philosophy of Religion.** ¾ or 1 unit. Prerequisite: One course in philosophy. WAINWRIGHT.

325. **Philosophy of Mind.** Philosophical problems arising in connection with mental phenomena; the relation of mind and body; free will and determinism; our knowledge of other minds; the self and personal identity. ¾ or 1 unit. Prerequisite: One course in philosophy.

326. **Metaphysics.** ¾ or 1 unit. Prerequisite: One course in philosophy.

327. **Scientific Method.** Methodology and epistemology; empirical knowledge and learning from experience; science and common sense; scientific explanation; historical examples; generalizing and historical science; natural and social science; historicism; explanation in the social sciences. ¾ or 1 unit. AGASSI.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. ¾ or 1 unit. Prerequisite: One course in philosophy. TURQUETTE.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. ¾ or 1 unit. Prerequisite: One course in philosophy. CATON, LINSKY.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method, and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. ¾ or 1 unit. Prerequisite: One course in philosophy. LINSKY, WILL.

332. **Perception and Knowledge.** A systematic study of basic problems in the philosophy of perception: perceiving as a mental state; the objects of perception; sensing, sensation, and sense-data; perception and the external world; perception as the basis of empirical knowledge. Traditional empiricist philosophies of perception will be examined and contemporary criticisms and defenses will be assessed. ¾ or 1 unit. Prerequisite: One course in philosophy. SWARTZ.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. ¾ or 1 unit. TURQUETTE.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. ¾ or 1 unit. Prerequisite: Philosophy 333. TURQUETTE.

335. **Social Philosophy.** The nature of social organization as seen from economic, moral, and political, standpoints; various senses of freedom; relations between organization and freedom; the free society. ¾ or 1 unit. Prerequisite: One course in philosophy.

336. **Philosophy of Law and of the State.** ¾ or 1 unit. Prerequisite: One course in philosophy.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth. A study of the functions of language, definition, meaning and verification, semantical paradoxes. ¾ or 1 unit. Prerequisite: A course in logic. LINSKY.

338. **Philosophies of Language.** Same as Linguistics 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. KRETZMANN.

339. **Philosophy of Mathematics.** Introduction to some of the main philosophical problems and contemporary viewpoints concerning mathematical concepts, mathematical methods, and the nature of mathematical truths. The concept of infinity; conventionalism and formalism; the distinction between analytic and synthetic truths; necessity; mathematics and the problem of universals; other related topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

340. **The Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas,* taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

341. **Existentialism.** An introduction to contemporary philosophical existentialism. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. ¾ or 1 unit. Prerequisite: One course in philosophy. GOTSHALK.

361. **Comparative Religions: The Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

362. **Comparative Religions: The Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

PHYSICAL EDUCATION

The department offers programs of graduate study leading to the Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, including sport, dance, and exercise. The Doctor of Philosophy program also permits candidates to specialize in the areas of health

education, safety education, and recreation. (See Health and Safety Education, page 183, and Recreation and Municipal Park Administration, page 307.)

Admission requirements for a major in the field are: (1) a minimum grade-point average of 4.0 for the last sixty hours of undergraduate study (applicants whose averages are below 4.0 but above 3.75 will be considered on an individual basis); (2) thirty hours of approved credit in physical education or related fields; (3) eighteen hours of approved undergraduate credit in science; (4) sixteen hours of undergraduate credit in education; and (5) a course in statistics or measurement.

Master of Science. Graduation requirements for this degree are: eight units to include (1) four units in physical education or approved related courses (health education or recreation); (2) two units in education including two of the following: History and Philosophy of Education 301, 302, 303, 304; and Educational Psychology 311 and 312; (3) Physical Education 490, one semester, no credit; (4) thesis, two units.

Candidates may petition to waive the thesis and seminar requirements but must take two additional units of credit and pass a final comprehensive written examination in physical education and related fields.

Doctor of Philosophy. Requirements for this degree are: twenty-four units of credit including (1) a minimum of eight units in physical education courses or approved related courses in health education, safety education, or recreation; (2) one minor for a minimum of four units, or two minors for a minimum of two units each; (3) Physical Education 490, and (4) presentation of an acceptable thesis of eight units.

GRADUATE FACULTY

Professors: E. F. Zeigler (Head of Department), T. K. Cureton, Jr., A. W. Hubbard, Laura J. Huelster, C. O. Jackson, H. E. Kenney, C. G. Knapp, K. J. McCristal.

Associate Professors: Charlotte L. Lambert, D. O. Mathews, R. H. Pohndorf, R. E. Shelton, Olive G. Young.

Assistant Professors: A. W. Flath, A. C. Moore, Jr., B. J. Noble, J. T. Powell, Marianna Trekell, H. J. VanderZwaag.

COURSES FOR GRADUATES

401. **Administration of Physical Education and Sport.** Analysis of completed research relating to theory and practice of administration in physical education and sport; the development of policy statements and procedures manuals for the various educational levels; experience in the use of the case plan of instruction as a teaching technique for the development of competencies and knowledges relating to human relations and administration in this specialized field. 1 unit. Prerequisite: Physical Education for Men (or Women) 204 or equivalent. Huelster, Jackson, Pohndorf, Zeigler.

402. **History of Physical Education and Sport.** An analysis of the research literature related to the historical foundations of physical education and sport; discussion of such persistent historical problems as the influence of economics, politics and nationalism, curriculum and methods of instruction, professional preparation, the healthy body, dance, the use of leisure, and amateur and professional sport. 1 unit. Prerequisite: Physical Education for Men (or Women) 209 or equivalent. Flath, VanderZwaag, Zeigler.

406. **Philosophy of Physical Education and Sport.** Philosophical analysis of physical education and sport (with some reference to school health and recreation) in the light of the leading philosophical tendencies and possible implications for public and private education: analysis of completed research; includes

delineation of one's personal philosophy and the use of structural philosophical analysis as a research technique. 1 unit. Prerequisite: Philosophy 101 and History and Philosophy of Education 305. HUELSTER, VANDERZWAAG, ZEIGLER.

407. **Sport Psychology.** Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, perception and emotion in sport situations; review of literature; independent projects. 1 unit. Prerequisite: Psychology 100; Educational Psychology 211; consent of instructor. HUBBARD, YOUNG.

408. **Principles of Kinesiotherapy.** Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically prescribed clinical training; literature; research. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, and physiology of exercise, or consent of instructor. SHELTON.

450. **Trends and Techniques in Rehabilitation.** Philosophy of rehabilitation; education of the handicapped (blind and partially sighted, deaf and hard of hearing, mentally handicapped, socially maladjusted, crippled, cardiac, epileptic, speech deviate, etc.); state, federal, and community education and vocational training programs; literature; research. 1 unit. SHELTON.

451. **Scientific Foundations of Physical Fitness.** Scientific basis for physical fitness; analysis of fitness programs; analysis of fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. CURETON, NOBLE.

452. **Scientific Analysis of Physical Education Activities.** Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. CURETON, NOBLE.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. **Seminar.** Presentation and criticism of student theses; lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders. No credit. CURETON, STAFF.

493. **Special Projects.** Independent research on special projects. ½ or 1 unit. STAFF.

495. **Techniques of Research in Health, Physical Education, and Recreation.** Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. 1 unit. CURETON, HUBBARD, NOBLE.

499. **Thesis Research.** Preparation of theses in physical education. 0 to 4 units. STAFF.

PHYSICAL SCIENCES

A special program leading to the Master of Sciences in the Physical Sciences is available to meet the needs of secondary school teachers who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal

proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit are acceptable toward the degree. To qualify for the degree, a student must present at least one course in mathematics beyond calculus, for which calculus is prerequisite. In addition, he must have met the requirements for teacher certification.

Candidates for the Master of Science in the Teaching of the Physical Sciences, which is distinct from the program described above, must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. The courses in the physical sciences and the electives—which must normally give graduate credit—must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 4.0. Inquiries concerning these programs should be directed to Professor Don H. Secrest, 300a Noyes Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Physics.

There is opportunity for specialization in atomic and nuclear physics, including research with the betatrons, the cyclotron, and with radioactive sources; in nuclear magnetic resonance; in theoretical physics; in the physics of solids, including research on ionic crystals, metals, semiconductors, cryogenics, and surface physics; in plasma physics and aeronomy.

Requirements for admission to the Graduate College with a major in physics are twenty semester hours of physics, including Physics 321, 341, and 342 or the equivalent, and excluding courses in general physics, and an average of at least 3.75 for the last sixty hours of undergraduate work. Advanced undergraduate courses in light, thermodynamics, and atomic physics are strongly recommended.

The requirements for the Master of Science in Physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department.

Candidates for the Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Educational Psychology 311, 312, and one additional unit in education selected from History and Philosophy of Education 301, 302, 303, and 304. Students applying for admission must present an average of 3.75 for the last sixty hours of undergraduate work; applications of students with averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor G. M. Almy, 211 Physics Building.

For information concerning applied mathematics, see page 252; for information about biophysics, see pages 76 and 227. A doctoral program in chemical physics is described on page 87.

GRADUATE FACULTY

Professors: G. M. Almy (Head of Department), F. T. Adler, J. S. Allen, D. Alpert, G. Ascoli, P. Axel, J. Bardeen, F. C. Brown, R. M. Brown,

W. D. Compton, H. G. Drickamer, L. D. Fosdick, H. Frauenfelder, L. Goldstein, E. L. Goldwasser, A. V. Granato, R. Haag, P. Handler, A. O. Hanson, R. D. Hill, J. D. Jackson, J. S. Koehler, L. J. Koester, P. G. Kruger, U. E. Kruse, L. S. Lavatelli, D. Lazarus, E. M. Lyman, D. E. Mapother, R. J. Maurer, B. H. McCormick, K. Nishijima, J. R. Pasta, D. Pines, D. G. Ravenhall, C. S. Robinson, C. T. Sah, R. D. Sard, C. B. Satterthwaite, C. P. Slichter, J. H. Smith, J. N. Snyder, R. M. Thomson, A. Wattenberg, J. C. Wheatley, H. W. Wyld, M. E. Wyman.

Associate Professors: A. Abashian, M. K. Brussel, J. H. Cahn, D. M. Ginsberg, E. A. Jackson, L. P. Kadanoff, M. J. Raether, G. A. Russell, R. O. Simmons.

Assistant Professors: J. R. Ehrman, C. P. Flynn, M. V. Klein, F. M. Propst, R. L. Schult, H. J. Stapleton, D. C. Sutton, A. I. Yavin.

COURSES FOR GRADUATES

400. **Problems and Methods of Mathematical Physics.** Matrices and tensors; analytic functions of a complex variable; conformal mapping; contour integration; ordinary differential equations: solutions at singular points, contour integral solutions, asymptotic expansions; eigenfunctions and eigenvalues; partial differential equations: Laplace's equation, wave equation, diffusion equation, Green's functions; Legendre, Bessel, confluent hypergeometric Mathieu, and elliptic functions; elementary difference equations. 1 unit. Prerequisite: Mathematics 342 or 345 or 347 or 387; Physics 322 and 342; or consent of instructor.

422. **Dynamics and Nonlinear Mechanics.** Hamiltonian mechanics: Lagrange equations, Hamilton's canonical equations, contact transformations, Lagrange and Poincare invariants, Hamilton-Jacobi equation and Huygens' principle; perturbation theory, relaxation oscillations and stability of periodic motion, theory of cosmotron orbits, three-body problems. 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. **Relativity and Cosmology.** Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor.

435. **Theory of Semiconductors and Semiconductor Devices.** Same as Electrical Engineering 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

436. **Selected Topics in Physics of Solids.** The following topics are offered in rotation, one or two each semester.

(a) **Imperfections in Metals.** Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, on physical properties, on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) **Imperfections in Ionic Crystals.** Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) **Magnetic Properties of Solids.** Quantum theory of diamagnetism, paramagnetism, ferromagnetism; elements of magnetic resonance and relaxation. 1 unit. Prerequisite: Physics 482 and 490 or consent of instructor.

441. **Electrodynamics.** Electrostatics; Laplace's and Poisson's equations; boundary value problems; spherical harmonics; multiple potentials; dielectrics; microscopic and macroscopic fields; electric susceptibility; magnetostatics; magnetic multipoles; magnetic media; conducting media; Maxwell's equations; field energy and momentum; electromagnetic waves; reflection and refraction; dispersion; wave packets; causality; diffraction; wave guides and cavity resonators; simple aspects of magnetohydrodynamics and plasmas. 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. **Electrodynamics.** Special theory of relativity; covariant formulation of electrodynamics; charged particle dynamics; high energy particle accelerators; energy loss by charged particles traversing matter; multiple scattering; Lienard-Wiechert potentials; radiation by charged particles; radiation loss in particle accelerators; Thomson scattering; bremsstrahlung; Weiszacker-Williams method; inner bremsstrahlung; Cerenkov radiation; radiative reaction; natural line breadth; multiple expansion of radiation field; Lagrangian and Hamiltonian formulation of electrodynamics. 1 unit. Prerequisite: Physics 441.

455. **Reactor Physics, I.** Same as Nuclear Engineering 455. An introduction to the physical concepts of reactor analysis; nuclear cross section; diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Physics 282 or 382; Mathematics 343 and 345, or consent of instructor.

456. **Reactor Physics, II.** Same as Nuclear Engineering 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Physics 455 or consent of instructor.

463. **Statistical Mechanics.** Statistical ensembles; the Maxwell-Boltzmann law; approach to equilibrium; quantum statistical mechanics; application of statistical mechanics to thermodynamic processes. 1 unit. Prerequisite: Physics 360, 481, or consent of instructor.

465. **Plasma Physics.** Basic equations of magnetohydrodynamics; orbit theory; stability of plasma configurations; hydromagnetic waves; plasma oscillations; high-frequency instabilities; spontaneous fluctuation theory; Fokker-Planck equation; transport processes; oscillations in a magnetic field; interaction of electromagnetic waves with plasmas. 1 unit. Prerequisite: Physics 362 and 441 or Electrical Engineering 423 or consent of instructor.

467. **Atomic Collision Processes.** Same as Electrical Engineering 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photo-processes and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

480. **Quantum Mechanics, I.** Introduction to concepts of quantum theory, with applications. Review of classical Lagrangian mechanics; historical review of quantum phenomena, Bohr theory, and the wave nature of matter. Schrödinger wave equation; one-dimensional potential well and barrier penetration problems; three-dimensional problems, angular momentum, hydrogen atom; simple stationary state perturbation theory, perturbation of energy levels, Stark effect, normal Zeeman effect. 1 unit. Prerequisite: Physics 322 and 342; a course in atomic physics.

481. **Quantum Mechanics, II.** Principally applications to atomic and molecular structure. Electron spin; spin-orbit coupling, anomalous Zeeman effect; semi-classical treatment of emission and absorption of radiation with examples; selection rules, atomic spectra, x-ray spectra; Pauli principle, helium atom, exchange energy; periodic system of elements, Fermi-Thomas atom; diatomic molecules, electronic motion, vibrational and rotational motion, band spectra; simple collision problems, partial wave analysis. Born approximation. 1 unit. Prerequisite: Physics 480 or consent of instructor.

482. **Quantum Mechanics, III.** Formal structure of quantum theory; quantum theory of angular momentum, vector addition coefficients, simple tensor operators; collision problems, inelastic scattering, formal scattering theory; elementary treatment of quantization of the radiation field and the interaction of light with matter; introduction to Dirac electron theory. 1 unit. Prerequisite: Physics 481 and 422, or consent of instructor.

483. **Nuclear Physics.** Nuclear particles; conservation laws; nuclear properties deduced from systematics of stable nuclei; unstable nuclei and radioactivity; nuclear energy levels and transitions; independent particle models; introduction to nuclear reactions; selected experimental techniques. 1 unit. Prerequisite: Physics 481 or consent of instructor.

484. **Nuclear Physics.** Slow neutron physics and the density of energy levels; nuclear reactions; the compound nucleus model; direct interactions; fission; coulomb excitation and the collective model; beta decay; photonuclear effect; heavy ion reactions; nuclear forces. 1 unit. Prerequisite: Physics 483 or consent of instructor.

487. **Topics in Advanced Quantum Theory.** The following topics are offered alternately, but not every year:
(a) **Advanced Quantum Mechanics.** Relativistic quantum mechanics of a single particle. Dirac equation, Lorentz transformation, properties and bilinear covariants, bound state and scattering problems, Möller and Breit interactions, elementary radiation theory, relativistic photoeffect, bremsstrahlung, formal scattering theory, S-matrix, symmetry principles. 1 unit. Prerequisite: Physics 482.
(b) **Quantum Field Theory.** Field quantization; scalar and pseudoscalar meson field; electromagnetic field, Dirac field, interacting fields, electrodynamics; meson theory; interaction representation; S-matrix; covariant perturbation theory and Feynman diagrams; Compton scattering; Möller scattering; bremsstrahlung; pair annihilation; charge and mass renormalization; Lamb shift; anomalous electron magnetic moment; Heisenberg representation; dispersion relations; recent developments. 1 unit. Prerequisite: Physics 487a.

488. **Advanced Topics in Nuclear and Particle Physics.** The following topics are offered alternately, but not every year:
(a) **Nuclear Physics.** Nuclear forces, two nucleon problems, structure of light nuclei, nuclear models, interaction of electromagnetic radiation with nuclei, beta decay, theory of nuclear reactions, high energy nuclear interactions, properties of nuclear matter. 1 unit. Prerequisite: Physics 482 and 484, or consent of instructor.
(b) **Physics of Elementary Particles.** Empirical facts, phenomenological discussion of the production, scattering and absorption of pi mesons, theoretical models, K-mesons and hyperons, classification schemes for elementary particles and their strong interactions, particle-antiparticle phenomena, decay processes. 1 unit. Prerequisite: Physics 482 and 484, or consent of instructor.

489. **Solid State Physics, I.** Introduction to the modern theory of crystalline materials. Topics treated include crystal symmetry, elastic and thermal properties of solids, optical properties, point defects and imperfections in crystals. 1 unit. Prerequisite: Physics 360, 362, 381, 480, or consent of instructor.

490. **Solid State Physics, II.** Introduction to band theory of solids, free electron model, electrons in periodic potential, cohesion, transport properties of metals and semiconductors, experimental methods for determining band structure. 1 unit. Prerequisite: Physics 481, 489, or consent of instructor.

491. **Solid State Physics, III.** Elementary excitations in solids; phonons, electrons, plasmons, excitons, spin waves, treated as elementary excitations in interaction with one another and with external fields and particles. 1 unit. Prerequisite: Physics 481.

497. **Individual Study.** Individual study in a subject not covered in course offerings may be arranged for credit by registration under this number. ½ or 1 unit. Prerequisite: Varies with subject studied.

498. **Special Topics in Modern Physics.** Seminar. Lecture courses in topics of current interest are given under this number. Subjects are announced in the Time Table. ½ or 1 unit. Prerequisite: Varies with subject under consideration.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Modern Experimental Physics, I.** Techniques and experiments in the physics of atoms, atomic nuclei, molecules, the solid state, and other areas of modern physical research. 1 unit. Prerequisite: Physics 342; concurrent registration in Physics 381.

304. **Modern Experimental Physics, II.** Continuation of Physics 303. 1 unit. Prerequisite: Physics 303.

321. **Theoretical Mechanics.** Motion of a particle in one, two, and three dimensions with applications; Kepler's laws and planetary motion; scattering of particles; conservation laws; motion of a rigid body in two dimensions; statics of extended systems. Lectures and problems. 1 unit. No credit for graduate physics majors. Prerequisite: General physics; registration in Mathematics 341, 345, or 349.

322. **Theoretical Mechanics.** Continuation of Physics 321. Moving coordinate frames, fictitious forces; special theory of relativity, conservation laws, particle motion and creation; rigid body motion in three dimensions; gravitation and earth motion; generalized coordinates and Lagrange's equations; constraints, small vibrations. 1 unit. Prerequisite: Physics 321.

341. **Electricity and Magnetism.** The fundamental laws are introduced using the vector notation stressing Maxwell's equations in the integral form. Topics covered with applications and problems include direct current circuits, circuit theorems, electric and magnetic fields, Gauss's Law, capacitance and inductance; energy and forces associated with these fields in free space and in matter. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. ½ or 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics; credit or registration in Mathematics 341, 343, or 345, or consent of instructor.

342. **Electricity and Magnetism.** Continuation of Physics 341. Effects associated with changing fields and currents, Faraday's Law, displacement current, transient currents, complex variables in circuit analysis, coupled circuits, and circuit theorems; an introduction to the generation and propagation of electromagnetic waves and the wave equations. ½ or 1 unit. No credit is given to graduate physics majors. Prerequisite: Physics 341.

343. **Electronic Circuits.** The physics of vacuum tube and semiconductor devices; theory and application of these devices as linear circuit elements in power supplies, amplifiers, communication circuits and control circuits. Emphasis

is on experimental techniques. Lectures, problems, and laboratory. 1 unit. Prerequisite: Physics 341 or consent of instructor.

344. **Electronic Circuits.** Continuation of Physics 343. Electronic instruments and techniques used in research in physics and digital computers; theory and experiments emphasizing the use and design of nonlinear circuits, e.g., multivibrators, pulse generators, counters, etc.; theory of switching circuits; special topics. 1 unit. Prerequisite: Physics 343 or equivalent.

347. **Electromagnetic Theory and Boundary Value Problems.** Beginning with Maxwell's equations, this course treats electrostatic and magnetostatic boundary value problems and multipole expansions with orthogonal polynomials, boundary value problems in quasistatic and radiation fields, simple radiating systems, and scattering of scalar waves. 1 unit. Prerequisite: Mathematics 343 and 345, Physics 342 or Electrical Engineering 229; or consent of instructor.

360. **Thermodynamics.** Zeroth, first, second, and third laws of thermodynamics; applications to simple physical and chemical systems; thermodynamics inequalities and equilibrium; phase transitions. Lectures and problems. 1 unit. Prerequisite: General physics and calculus; senior standing in physics is advised.

362. **Kinetic Theory and Statistics.** A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose, Einstein, and Fermi-Dirac statistics and applications. 1 unit. Prerequisite: Physics 360 or consent of instructor.

366. **Aeronomy: Physics of the Upper Atmosphere and Space.** Same as Astronomy and Electrical Engineering 366. Structure and composition of the earth's upper atmosphere; solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

371. **Light.** Wave optics: description and superposition of waves, coherence, interference, diffraction, polarization, and dispersion. Geometrical optics: image formation, optical systems, thick lens theory, image defects; applications to optical instruments. Lectures, problems, and laboratory. ½ to 1 unit. Prerequisite: General physics, Mathematics 345 or consent of instructor.

381. **Atomic Physics.** Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345; concurrent registration in Physics 385 is recommended.

382. **Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. 1 unit. Prerequisite: Physics 381 or 383.

383. **Atomic Physics and Quantum Theory for Engineers.** Introduction to the basic concepts of quantum theory which underlie modern theories of the properties of materials. Topics covered include elements of atomic and nuclear theory, kinetic theory and statistical mechanics, quantum theory, and simple

applications, atomic spectra and atomic structure, molecular structure and chemical binding. Lectures and problems. ¾ or 1 unit. Prerequisite: General physics; general chemistry; Mathematics 345 or equivalent.

385. **Introduction to Quantum Mechanics.** Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles, applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. 1 unit. Prerequisite: Mathematics 343, Mathematics 345, or consent of instructor; registration in Physics 381 is recommended.

PHYSIOLOGY AND BIOPHYSICS

See descriptions and course listings under Life Sciences, page 226.

PLANT PATHOLOGY

Graduate work leading to the Master of Science and Doctor of Philosophy is available in the Department of Plant Pathology. Students may choose a major, joint major, or minor in plant pathology. The following fields are available for specialization: diseases of field crops, forest and shade trees, fruit crops, ornamentals, turf and lawn grasses, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science must meet the general requirements of the Graduate College, present an acceptable thesis, and pass an oral examination before a committee of five staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students are accepted with a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.49 are considered on an individual basis.

GRADUATE FACULTY

Professors: W. M. Bever (Head of Department), L. M. Black, J. C. Carter, J. W. Gerdemann, D. Gottlieb, A. L. Hooker, M. B. Linn, D. Powell, H. H. Thornberry.

Associate Professor: M. P. Britton.

Assistant Professors: D. W. Chamberlain, P. D. Shaw, D. P. Taylor.

COURSES FOR GRADUATES

401. **Diseases of Forest and Shade Trees.** A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. ½ or 1 unit. Prerequisite: Plant Pathology 301 or consent of instructor. Carter.

403. **Physiology of Fungi.** Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasit-

ism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Organic chemistry or biochemistry; mycology, plant pathology, or microbiology. GOTTLIEB.

404. **Plant Virology.** Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. ½ or 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Consent of instructor. THORNBERRY.

417. **Discussions in Plant Pathology.** Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. ¼ unit. STAFF.

499. **Thesis Research.** Individual study and research required of all students working toward the Master of Science or Doctor of Philosophy in Plant Pathology. 0 to 4 units. Work can be taken in the following areas, subject to approval of the staff member concerned:
(a) **Biochemistry of Plant Disease.** STAFF.
(b) **Diseases of Corn; Genetics of Resistance.** HOOKER.
(c) **Diseases of Cereal Grains.** BEVER, HOOKER.
(d) **Diseases of Forest and Shade Trees.** CARTER.
(e) **Disease of Fruit Crops; Fungicides.** POWELL.
(f) **Diseases of Leguminous Crops; Root Diseases.** GERDEMANN.
(g) **Diseases of Turf and Lawn Grasses.** BRITTON.
(h) **Diseases of Soybeans.** CHAMBERLAIN.
(i) **Diseases of Vegetable and Canning Crops.** LINN.
(j) **Nematode Diseases.** TAYLOR.
(k) **Physiology of Fungi; Antibiotics.** GOTTLIEB.
(l) **Plant Virology.** BLACK, THORNBERRY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** For students desiring to study specific problems not assigned in other courses. ¼ to 1 unit; maximum accumulated credit, 2 units. STAFF.

301. **Plant Pathology.** Same as Botany 301. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. 1 unit. Prerequisite: One year of plant science, including Botany 100. BLACK.

302. **Research Methods in Plant Pathology.** Techniques for the isolation, identification, culture of, and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. ¾ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Plant Pathology 204 or 301. GERDEMANN, LINN.

303. **Plant Nematology.** Experimental techniques, nematode anatomy, taxonomy, biology, and host-parasite relations; intensive study of selected groups including foliar, stem, root-knot, and cyst nematodes; interaction with bacteria, fungi, and viruses in plant disease development; control principles. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Plant Pathology 204 or 301 and Zoology 101 and 104, or equivalent.

304. **Forest Tree Diseases and Wood Deterioration.** Symptoms, causal agents, and control of the major forest tree diseases. Causes and control of wood deterioration. ½ unit. GERDEMANN.

305. **Principles of Plant Disease Control.** A study of the basic concepts of both nonchemical and chemical methods used for the control of plant diseases. Lectures, discussions, and assigned reading. ¾ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Plant Pathology 204 or 301; Chemistry 132 or 133; or consent of instructor. POWELL.

306. **Epiphytology and Diagnosis of Plant Diseases.** Detailed consideration of factors influencing the incidence and severity of diseases caused by fungi, bacteria, viruses, and nematodes; ecological factors as etiological agents, and techniques for determining the intensity of epiphytotics; plant disease identification. ¾ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Plant Pathology 204 or 301. BRITTON.

377. **Diseases of Field Crops.** Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. ½ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Plant Pathology 204 or 301. HOOKER.

POLITICAL SCIENCE

The Department of Political Science offers work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, political behavior, political theory and jurisprudence.

Admission to graduate work in political science requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. The student must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history). If a student making political science his major is taking both of his minors in other departments, one of them must be in history, economics, or sociology.

The department also administers a program leading to the Master of Arts in Public Administration. A grade-point average of at least 3.75 and a study proposal leading to a well-defined career or professional objective, approved by the department, are required for admission. The program is offered both in Urbana and through extramural classes in Springfield, and is matched to the individual needs and objectives of students. Programs for students without public service employment usually incorporate an internship of at least three months. Further details may be obtained from the department, 325 Lincoln Hall.

Several courses given in other departments are so closely related to those in political science that a graduate student whose major is political science may be permitted on petition to take such courses as part of his major work. Attention is called to the courses in public law in the College of Law, the courses in public finance in the College of Commerce and Business Administration, the courses in city and regional planning in the College of Fine and Applied Arts, and the courses in municipal and sanitary engineering in the College of Engineering.

Graduate students in other departments who choose political science as a minor must have had at least six hours of undergraduate work in political science and three hours in economics, sociology, or history.

GRADUATE FACULTY

Professors: C. B. HAGAN (Chairman of Department), R. DANGERFIELD, M. EDELMAN, N. F. GARVEY, S. K. GOVE, J. M. HEIKOFF, E. G. LEWIS, P. MONYPENNY, R. E. SCOTT, C. F. SNIDER, G. Y. STEINER, R. P. STRANGE, F. G. WILSON.

Associate Professors: T. J. ANTON, G. W. FISHER, G. MANNER, T. PAGE.

Assistant Professors: B. GLAD, J. F. HOUGH, D. KRAMER, S. S. NAGEL, D. G. SULLIVAN.

Visiting Lecturer: P. S. WILDER, JR.

COURSES FOR GRADUATES

400. **Classics of Political Science.** Reading, analysis, and discussion of leading works on politics and government. 1 unit. STAFF.

401. **History of Political Theories.** Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. 1 unit. WILSON.

402. **History of Political Theories.** Reading and analysis of the leading political thinkers from the middle of the seventeenth century to the present. 1 unit. WILSON.

406. **Municipal Administration.** Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. 1 unit. ANTON.

410. **Problems in Rural Local Government.** Research in selected topics. 1 unit. SNIDER.

412. **Problems in State Government.** Research in selected topics in American state government. 1 unit. SNIDER.

420. **Formation of Public Policy.** Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, judicial activity. 1 unit. HAGAN.

421. **Government and the Economic Order.** Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. 1 unit. HAGAN.

425. **Personality and Political Process.** Rationality and its limits in political processes: the functions of symbols and myth in politics; political involvement and quiescence; nonrational elements in legislation and administration. 1 unit. Prerequisite: Consent of instructor. EDELMAN.

426. **Political Parties.** Special problems in political parties; methods and materials of research in this field. 1 unit. WILDER.

427. **Psychological Bases of Political Behavior.** This course is intended to introduce the student to relations between psychological mechanisms and life history factors and individual or group political behavior. Topics covered in the course include national loyalty and ideology, mass public and political involvement, political authority, and individual compliance. 1 unit.

431. **Problems of British Government.** Special topics relating to British government. 1 unit. LEWIS.

435. **Problems in the Government of Soviet Russia.** Special topics relating to the government of the Soviet Union. 1 unit. HOUGH.

440. **Comparative Politics and the Political Process.** The comparative study of selected national political systems or of specific institutional forces that influence the making and application of public policy in several countries. The countries studied and the legal and extra-legal political agencies considered vary according to the person conducting the seminar. 1 unit. This course may be repeated for credit not to exceed a total of three units. STAFF.

441. **Politics in the Developing States.** An examination of the political processes in the developing countries. The general problems arising in the transition from traditional societies to modern industrial states are examined to describe the typical patterns of political change. Special attention is given to contemporary literature and studies. 1 unit. Prerequisite: Consent of instructor. SCOTT.

442. **Problems of Latin American Politics and Government.** Special topics relating to Latin American politics and government. Individual countries may be

studied or comparative analysis of particular political and governmental functions or problems may be undertaken. Course may be repeated for credit not to exceed two units. 1 unit. Prerequisite: Political Science 441 or equivalent. SCOTT.

447. **Problems of Asian Politics and Government.** Special topics relating to Asian politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. Course may be repeated for credit not to exceed three units. 1 unit. Prerequisite: Political Science 441 or equivalent.

450. **Contemporary Governmental Problems.** Special problems of current importance. Designed especially for students not majoring in political science. S; 1 unit. This course may be repeated for credit not to exceed a total of three units. STAFF.

451. **Constitutional Law.** Research in selected topics in the American constitutional system. 1 unit. Prerequisite: Political Science 351 or equivalent. NAGEL.

465. **Problems in Administrative Management.** An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

466. **Current Administrative Theory.** A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision-making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. 1 unit. MONYPENNY.

471. **Problems in International Organization.** Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. 1 unit.

481. **Foreign Relations of the United States.** Special problems in the development and conduct of American foreign policy. 1 unit. DANGERFIELD.

484. **International Relations.** An analysis of the approaches and methods used in the study of international relations; the characteristics of states and of international systems; the problem of conflict and its resolution. 1 unit. JENSEN.

485. **International Law.** Research on selected topics. 1 unit. MANNER.

490. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit.

491. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit. Prerequisite: Political Science 490.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. 1 unit. STAFF.

495. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; the present state of research in political science. 1 unit. HAGAN, MONYPENNY.

496. **Political Concepts—Formulation and Measurement.** The course is designed to indicate the relevance of certain research techniques for answering questions of concern in political science and to indicate the range of tools available to the student. Problems in concept formation are discusssed. Current methods of concept measurement are presented to the student in the context of political research problems. 1 unit.

497. **Research Design and Techniques.** This course is intended to introduce the student to problems of research design, data collection, data analysis and interpretation, sampling, and some simple measures of statistical association and significance. 1 unit. Prerequisite: Political Science 496.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. ½ or 1 unit. STEINER.

306. **Municipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. ½ or 1 unit. Prerequisite: Political Science 305, or Economics 102 and 103, or six hours of political science.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. ½ or 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; reorganization problems in the state; state-local relations; state finance; trends and prospects. Students do not receive credit for both Political Science 110 and 312. ½ or 1 unit. Prerequisite: Political Science 150 or 151. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. ½ or 1 unit. Prerequisite: Six hours of political science. HAGAN.

317. **The American Federal System.** The nature, justification, and problems of federalism; coordination of governmental efforts by contract, subsidies, and grants; comparison of federal systems. ½ or 1 unit. Prerequisite: Political Science 150 or 191. FISHER, STEINER.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. ½ or 1 unit. Prerequisite: Two courses in political science or in political science and economics. EDELMAN, HAGAN.

326. **American Political Parties.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor.

328. **Introduction to the Study of Political Behavior.** An analysis of the interrelations of political attitudes and public policy formation. Special attention

is given to the substantive areas of voting behavior, political leadership, and the rise of political mass movements. The course also includes a review of the literature on democratic and authoritarian personality types. ½ or 1 unit. Prerequisite: Political Science 150 or equivalent. SULLIVAN.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. ½ or 1 unit. LEWIS, STESLICKE.

335. **Government and Politics of the Soviet Union.** Evolution, structure, and functioning of the Soviet system of government; the theories, structure, and functioning of the Communist party of the Soviet Union. ½ or 1 unit. HOUGH.

336. **Governments and Politics in Western Continental Europe.** An analysis of the major governmental systems of Continental Europe; the evolution, structure, and functioning of the political institutions of France, Germany, Italy, Spain, Switzerland, and the Scandinavian countries as illustrations of multiparty and dictatorial types of governments. ½ or 1 unit. LEWIS.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin American political institutions; systems of government; public administrative systems; party government; international policies of Latin American governments. ½ or 1 unit. Prerequisite: Six hours of political science. SCOTT.

343. **Political Systems and Structures of Latin American Countries.** The political process, generally of selected Latin American countries at different levels of political development, with stress on the interaction between political infrastructure and more formal agencies of government. May include cross-national comparison of the function of such factors as political culture, party system, bureaucracy, or the military establishment ½ or 1 unit. Prerequisite: Political Science 342. SCOTT.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

346. **Theory and Practice of Communism.** A survey of the international Communist movement. The origins of modern communism and the nineteenth-century development of its doctrines; the Russian Revolution; Lenin and Stalin, the U.S.S.R. as a model for communism; the regional development of Communist parties. ½ or 1 unit. KRAMER, WILSON.

347. **Governments and Politics of Southeast Asia.** A comparative analysis of the political development of the countries of Southeast Asia, the lands to the east of India and south of China, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

348. **Governments and Politics of East Asia.** A comparative analysis of the governments and politics of China, Japan, and Korea; their international relations and foreign policies; traditional as well as contemporary forms of political behavior; nationalism and communism as political forces. ½ or 1 unit. STESLICKE.

349. **Governments and Politics of South Asia.** A comparative analysis of the political development of India, Pakistan, Ceylon, and the lesser lands of South Asia, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. ½ or 1 unit. Prerequisite: Political Science 150 or 191. KRAMER, NAGEL.

355. **The Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attenion to the role of law and judges. ½ or 1 unit. Prerequisite: Political Science 150 or 191. KRAMER, NAGEL.

356. **Public Administration and the Judicial Process.** The scope of administrative powers and their relation to private rights. A comparison of the processes of decision in administrative agencies and in the courts; the interests served by each; the impact of judicial review of administrative decisions upon administrative procedure and policy; the constitutional and statutory bases of review; the legal accountability of public officers versus political accountability. ½ or 1 unit. Prerequisite: Political Science 305 or 351 or consent of instructor. NAGEL.

357. **The Process of Law Enforcement.** Problems in the procedure of law enforcement including; the nature and ramification of crime; the nature and sources of law; character and types of criminal law; structure of the court system and its role in criminal enforcement; agencies of law enforcement—federal, state, and local; interstate crime control; the police and crime detection; prosecution of criminal offenses; problems of judicial procedure; and correctional procedures. ½ unit. Prerequisite: Political Science 150 or 151. GARVEY.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MONYPENNY, PAGE.

362. **Administrative Organization and Policy Development.** Dynamics of policy formulation in public administrative agencies; current developments in organizational theory and their significance for public administration; origin of public administrative organizations; interpersonal behavior; large-scale organizations and centralization; external support and opposition; policy formation and problems of compliance. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor. EDELMAN.

365. **Government and Labor.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191. EDELMAN.

366. **Tools of Public Management.** A critical survey of the tools of analysis available to overhead functions of public management in key areas of decision; emphasis on personnel administration and manpower utilization, budgetary processes and fiscal controls, and several methods of administrative analysis —organizational studies, procedures engineering, information processing, and operations research. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

371. **World International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the United Na-

tions and related agencies and to their evolution from the League of Nations system. ½ or 1 unit.

372. **Regional International Organizations.** Descriptive and comparative analysis of various regional international organizations, their role in contemporary politics and their relationship to the United Nations system; structure, functions, and accomplishments of North Atlantic Treaty Organization, Southeast Asia Treaty Organization, Organization of American States, and other regional international organizations. ½ or 1 unit. STESLICKE.

380. **Comparative Foreign Policies.** An analysis of the formulation and substance of the foreign policies of select nations of the world. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor. HEISLER.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. ½ or 1 unit. Prerequisite: Six hours of political science. GLAD.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. ½ or 1 unit. Prerequisite: Political Science 381 or consent of instructor. DANGERFIELD, GLAD.

383. **Soviet Foreign Policy.** A survey of Soviet foreign policy from 1917 to the present, with emphasis upon the forces shaping this policy. Special attention is given to the interplay of ideology and national interest in policy formulation. ½ or 1 unit. HOUGH.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. ½ or 1 unit. MANNER.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. ½ or 1 unit. MANNER.

387. **National Security Policy.** An examination of the organization and formulation of current American defense policy; the theory of deterrence, with special reference to American and Soviet military strategy; the problems of disarmament and arms control. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

390. **Methods of Political Analysis.** Presentation of the analytic processes in the development of concepts, hypotheses, and theories. Discussion of the derivation, formulation, and specification of research problems to be related to basic methodologies and modes of analysis. Applications to political science. ½ unit. Prerequisite: Political Science 150 or 191 or consent of instructor.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation, and the Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. ½ or 1 unit. WILSON.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; anti-democratic thought and totalitarian regimes. ½ or 1 unit.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. ½ or 1 unit. Offered in 1965-1966 and in alternate years. WILSON.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the Master of Arts and Doctor of Philosophy.

Fields. Doctoral programs are offered in the following special areas of psychology: general experimental psychology, personality, social psychology, psychological measurement, clinical and counseling psychology, engineering psychology, industrial psychology, school psychology, child psychology, psycholinguistics.

Admission. The candidate must meet the following departmental requirements: (1) a minimum of fifteen semester hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of at least 4.0. Preference is given to students who have taken college mathematics and two years of French, Russian, or German. Because it is necessary to limit admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The Master of Arts is awarded to candidates who complete satisfactorily eight units of course work and present an acceptable thesis. The doctoral candidate must also complete an approved program of courses in his area of specialization.

In the fields of clinical and counseling psychology, and school psychology, the doctoral candidate must also complete the equivalent of a full-time academic year of internship in an agency approved by the Department of Psychology.

The Department of Psychology also offers a Master of Science degree in applied psychology to those students who have completed an undergraduate major in applied psychology at the University of Illinois. Students with a 3.5 average or higher may apply.

TRAINEESHIPS

United States Public Health Service Traineeships in Measurement and Clinical Psychology. Graduate students, including first-year applicants, are automatically considered for these appointments. No application is necessary. Current stipends (tax-free) are: Level I, $1,800; Level II, $2,000; Level III, $2,400; Level IV, $3,000. The trainee has no duties other than full-time graduate work.

Veterans Administration Traineeships in Clinical and in Counseling Psychology. First-year students are not eligible for these appointments. Applicants for advanced standing may apply for a traineeship by a letter addressed to the head of the Department of Psychology. The trainee works approximately half-time in a Veterans Administration hospital as a Civil Service appointee.

GRADUATE FACULTY

Professors: L. G. Humphreys (Head of Department), J. A. Adams, W. C. Becker, R. B. Cattell, F. Costin, D. E. Dulany, C. W. Eriksen, T. N. Ewing, F. E. Fiedler, W. M. Gilbert, G. R. Grice, H. W. Hake, R. Hamlin, J. Hirsch, J. McV. Hunt, W. E. Kappauf, S. A. Kirk, L. H. Lanier, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, D. R. Peterson, I. D. Steiner, L. M. Stolurow, G. J. Thomas, L. R. Tucker.

Associate Professors: J. B. Cohen, H. L. Jacobs, Alice K. Jonietz, J. E. McGrath, H. C. Quay, D. T. Shannon, H. C. Triandis, Leigh M. Triandis, L. P. Ullmann, M. W. Weir, J. S. Wiggins.

Assistant Professors: L. C. Ate, N. H. Eisen, M. E. Fishbein, Angela Folsom, G. Z. Greenberg, C. L. Hulin, L. A. Jakobovits, W. E. Montague, H. L. Munsinger, S. M. Nealey, M. Wagman.

COURSES FOR GRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all the prerequisites.

402. **Systematic Psychology.** A critical analysis and comparison of modern and contemporary psychological systems. 1 unit. Prerequisite: Twelve hours of psychology. Dulany.

403. **Proseminar in General Psychology, I.** A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. 1 unit. Prerequisite: Twelve hours of psychology. Peterson, Staff.

404. **Proseminar in General Psychology, II.** Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. 1 unit. Prerequisite: Twelve hours of psychology. Kappauf, Staff.

408. **Design of Experiments in Psychology.** Advanced experimental designs in psychological research; special methods of data analysis. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Psychology 307. Kappauf.

409. **Psychological Scaling.** Same as Sociology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Psychology 307. Tucker.

411. **Advanced Physiological Psychology.** Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation, learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. O'Kelly.

415. **Experimental Sensory Psychology.** A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. Kappauf.

416. **Perception.** Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpretations. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Twelve hours of psychology. Hake.

417. **Experimental Psychology of Learning, I: Basic Processes.** A study of experimental investigation of basic learning processes with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. 1 unit. Prerequisite: Twelve hours of psychology. Grice.

418. **Experimental Psychology of Learning, II: Human Learning.** Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. 1 unit. Prerequisite: Psychology 417 or consent of instructor. Adams.

419. **Advanced Comparative Psychology.** A critical survey of techniques, results, and problems in the study of animal behavior and human behavior from the comparative-evolutionary point of view. Laboratory demonstrations and individual research problems. 1 unit. Prerequisite: Twelve hours of psychology or biology. Hirsch.

421. **Problems in Motivation.** 1 unit. Prerequisite: Twelve hours of psychology. JACOBS, O'KELLY.

425. **Psycholinguistics.** Same as Communications and Linguistics 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Communications and Linguistics 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Psychology 425; consent of instructor. MACLAY, OSGOOD.

427. **Engineering Psychology.** Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent. HAKE.

428. **Higher Process.** An examination of method, theory, and research in the study of thinking; status of cognition as a construct; verbal control of behavior; concepts, problem solving, attention, language and thought; cognitive process as a source of motivation: 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. DULANY.

431. **Psychological Measurement in Industry.** Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. 1 unit. Prerequisite: Psychology 307 or equivalent. HULIN.

435. **Motivation and Morale in Industry.** Same as Labor and Industrial Relations 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. H. C. TRIANDIS.

441. **Personality and Behavior Dynamics.** The cross-sectional structure of personality, the basic principles of behavior dynamics and the determinants which shape personality development are described. Special topics include typologies, trait measurement, conflict and anxiety, and mechanisms of defense. ½ unit. Prerequisite: Twelve hours of psychology. WIGGINS.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. ½ unit. Prerequisite: Psychology 338; consent of instructor.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 290 or equivalent. W. C. BECKER, SHANNON.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. 1 unit. Prerequisite: Psychology 443; consent of instructor. W. C. BECKER, SHANNON, WIGGINS.

445. **Behavior Modification.** A critical survey of issues, principles, practice, and research related to modifying human behavior. The course covers psychotherapeutic and somatic approaches; symptomatic relief and personality-restructuring goal-orientations; individual, family, group, milieu, and preventive community intervention. ½ unit. Prerequisite: Psychology 444. Registration in Psychology 447 is strongly recommended.

446. **Laboratory in Behavior Modification.** Practice in techniques of behavior modification with a focus on recent innovations. Research implications of the newer methods are examined. Small sections of the course are formed according to the specialized interests of students and staff. ½ unit. Prerequisite: Psychology 445.

447. **Practicum.** Supervised practice in the assessment and modification of problem behavior. A student may reregister for a maximum of one unit. ½ unit. Prerequisite: Credit or registration in Psychology 445 and 446.

451. **Advanced Social Psychology.** Same as Communications 451. A systematic and critical treatment of individual behavior variables in relation to group variables. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 255 or equivalent. STEINER.

456. **Psychology of Social Communication.** Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor. FISHBEIN.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Six units of graduate credit in psychology, including Psychology 451 or equivalent. STEINER.

459. **Leadership and Group Effectiveness.** Theories of leadership, methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Psychology 451 or equivalent. FIEDLER.

461. **Development Psychology.** Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. 1 unit. Prerequisite: Twelve hours of psychology or consent of instructor. HUNT, MUNSINGER.

462. **Human Abilities.** Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Psychology 307 or equivalent. HUMPHREYS.

463. **Research Methods in Clinical Psychology and Personality.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. ½ unit. Prerequisite: Psychology 306 and 403. ERIKSEN.

464. **Parental Behavior and Personality Development of Children.** A survey of naturalistic and experimental research relating parent behavior to the personality development of children. Coverage is given to problems of measurement and structure of parent and child behavior, problems in research design, and to important issues for a theory of social learning. 1 unit. Prerequisite: Psychology 306 or equivalent; consent of instructor.

467. **Personality Assessment.** Methods and theory in the quantitative assessment of personality; review of research findings and trends. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Psychology 307 or equivalent. W. C. BECKER, WIGGINS.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories con-

cerning the learning process, including the work of Hull, Tolman, and Guthrie. 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. GRICE.

483. **Psychology of Speech and Hearing Disorders, I.** Same as Speech 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** Same as Speech 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

485. **The Sampling of Human Populations and Social Organizations.** Same as Sociology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples—stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

490. **Individual Research.** For graduate students who wish to conduct research on special problems not included in a graduate theses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

492. **Psychology of Learning and Instruction.** Same as Educational Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON, STOLUROW.

493. **Seminar.** Discussion of current topics in their historical setting, with special emphasis on research problems. ½ or 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. STAFF.

494. **Multivariate Analysis in Psychology and Education.** Same as Educational Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER.

495. **Theory of Measurement.** Same as Educational Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307 or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. HASTINGS, TUCKER.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Quantitative Methods, I.** A lecture and laboratory course in the development and application of quantitative methods in psychological research. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. KAPPAUF, TUCKER.

307. **Quantitative Methods, II.** Continuation of Psychology 306. 1 unit. Prerequisite: Psychology 306. HUMPHREYS, KAPPAUF, TUCKER.

311. **Physiological Psychology.** A study of the physiological basis of behavior, including sensory processes, motivation, emotion, learning, and intelligence. ½ or 1 unit. Prerequisite: Six hours of psychology; Physiology 103 or 106, or Zoology 101. JACOBS, O'KELLY.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. ½ or 1 unit. Prerequisite: Six hours of psychology. JACOBS, O'KELLY.

330. **Experimental Psychology, I.** A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. ½ unit. Prerequisite: Psychology 235. HAKE.

331. **Experimental Psychology, II.** A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. ½ unit. Prerequisite: Psychology 235. GRICE.

332. **Research Methods in Social Psychology.** A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology 235 and 255. FISHBEIN, MCGRATH.

335. **Mathematical Formulations in Psychological Theory.** Mathematical formulations are illustrated by studying quantitative treatments of various psychological processes. Emphasis is on learning theory, psychophysical laws, and other selected topics. Simple mathematical tools will be developed as required. ½ or 1 unit. Prerequisite: Elementary statistics or probability, elementary calculus, and six hours of psychology, or consent of instructor. FRANKMANN.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. ½ or 1 unit. Prerequisite: Six hours of psychology. PETERSON.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. ½ or 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. MCALLISTER.

346. **Behavior Genetics.** Examination of the relations between genetic mechanisms, population structure, and individual differences in behavior. Survey of research and possible extensions of research on the genetics of behavior. Laboratory work on techniques of behavior study and genetic analysis. ½ or 1 unit. Prerequisite: Psychology 100 or 103 and a course in statistics. HIRSCH.

348. **The Psychology of Learning.** A survey of the basic facts and theories of the learning process. ½ or 1 unit. Prerequisite: Six hours of psychology. MOWRER.

355. **Industrial Social Psychology.** Same as Labor and Industrial Relations 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid in understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or 357. H. C. TRIANDIS.

356. **Human Factors in Equipment Design.** The contributions of psychological research to the design of equipment for efficient human use and operation.

Studies of the characteristics and limitations of the human individual which bear upon the equipment and machines best suited to his use. A survey of research on visual and auditory displays, controls, layout of consoles; complex man-machine systems; vigilance and isolation effects; design for efficient trouble-shooting and maintenance. Emphasis is placed upon the methods used in collecting data on these problems. Applications to engineering, industrial design, management, etc., are discussed. ½ or 1 unit. Prerequisite: Psychology 100 or 103, and one course in statistics or college mathematics.

357. **Psychology of Industrial Conflict.** Same as Labor and Industrial Relations 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN.

358. **Human Performance in Man-Machine Systems.** Examination of equipment and training variables that influence the human operator and the effectiveness of man-machine systems; methods of task analysis for the systematic determination of behavioral requirements; design and use of simulators and other training devices; measurement of operator proficiency; control and display variables in closed-loop tracking systems; motor and perceptual fatigue; effect of work load; contemporary issues. Field trips. Research project on equipment design. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. ADAMS.

360. **Modern Viewpoints in Psychology.** A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and psychoanalytic theory—as conceptions of man and as approaches to the study of learning, perception, personality, and social behavior. ½ or 1 unit. Prerequisite: Nine hours of psychology with an average grade of B, or consent of instructor. DULANY.

365. **Experimental Child Psychology.** Stress is placed on laboratory investigations of children's behavior, including perception, learning, and problem-solving. ½ or 1 unit. Prerequisite: Six hours of psychology with an average grade of B; a course in statistics. WEIR.

371. **Psychological Factors in Political Behavior.** An application of psychological methods and theories to the study of political behavior. Special attention is given to research methods and to content problems in voting behavior and national security policy. ½ or 1 unit. Prerequisite: Six hours beyond 100-level courses in psychology, political science, or sociology.

373. **Human Development in Cross-Cultural Perspective.** Same as Anthropology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, psychology, or sociology, or consent of instructor. CASAGRANDE, L. M. TRIANDIS.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369.

390. **Psychological Tests and Measurements.** The measurement of human behavior in psychological studies; the construction and use of psychological tests; introduction to tests of intelligence, achievement, personality, and interest;

practice in test construction, administration, and validation. Lectures and laboratory. 1 unit. Prerequisite: Psychology 235.

RADIO AND TELEVISION

The Department of Radio and Television offers work leading to the Master of Science in Radio and Television and the Master of Television. For the program leading to the Doctor of Philosophy in Communications, see page 109.

Admission to the program leading to the Master of Science requires: (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in radio-television or a related field, English, or the social sciences; (2) a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

Admission to the program leading to the Master of Television requires (1) meeting minimum requirements for admission to the Graduate College; (2) a bachelor's degree from an accredited institution, ordinarily with a major in radio, television, theatre arts, journalism, or some other area related to television; (3) the approval of an entrance committee.

Master of Science in Radio and Television. Requirements for this degree include:

(1) A major of four units or three units and one additional unit approved by the adviser. Candidates must select either Radio-Television 462 or Journalism 471. Candidates without acceptable undergraduate majors are required to complete Radio-Television 252 (Television Laboratory), 368, and Advertising 386.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A thesis of one or two units.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

Master of Television. This degree differs from the Master of Science program in these ways: it does not require a thesis, but instead requires study in special problems of television; it does not require a minor, but permits concentration in the fifth year in the radio and television field.

Requirements for the degree include a total of eight units of credit, with a minimum of six units selected from courses in the television sequence. The following courses must be included among these six units if they or their equivalents have not been completed on the undergraduate level: Radio-Television 462, one unit; Radio-Television 450, two units; Radio-Television 368, one-half unit, and Advertising 386, one-half unit. Candidates without undergraduate training acceptable for the program are required to complete the following undergraduate courses: Radio-Television 252 (Television Laboratory) and Radio-Television 261 (Principles of Radio and Television Broadcasting); but under exceptional circumstances, such as professional experience in television broadcasting, this requirement may be waived.

Students are expected to plan their programs around a special interest area which may include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

GRADUATE FACULTY

Professor: H. J. Skornia.

Associate Professors: H. V. Cordier (Head of Department), F. E. Schooley, W. L. Smalley.

Assistant Professor: H. W. Lippold, Jr.
Instructors: S. W. Saltzman, B. L. Sims.

COURSES FOR GRADUATES

450. Special Problems in Television. Project work for advanced students in specific areas of television, including news, advertising, directing, writing, etc. 1 to 2 units. Students may register for this course up to a total of four units. Prerequisite: A television course in the area of specialization; consent of instructor. Staff.

451. Television Program Management and Production. Problems in originating, planning, and producing television programs. 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor. Cordier.

462. Seminar in Radio and Television. Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. Skornia.

463. World Broadcasting. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new development as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor. Skornia.

490. Special Topics in Radio and Television. ½ or 1 unit. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in radio-television. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

350. Broadcast Playwriting. Fundamentals of radio and television dramatic writing; adaptations and original projects in both media. ½ unit. Prerequisite: Consent of instructor. Smalley.

354. Television Directing. The theory and techniques of directing the television program. Experience in directing laboratory productions. ½ unit. Prerequisite: Radio-Television 252; consent of instructor. Cordier.

355. Television News. News coverage, script preparation, use of visual materials, and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. ½ unit. Prerequisite: Consent of instructor. Lippold.

356. Cinematography for Television. The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. ½ unit. Prerequisite: Consent of instructor. Sims.

360. Educational Uses of Television and Radio. Same as Communications 360 and Secondary and Continuing Education 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. McIntyre, Skornia.

362. Radio and Television Station Management. A study of the organization and administration of the radio and television staff and station; public relations, personnel management, and station operation; analysis of station and agency

relationships and radio and television sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. ½ unit. Prerequisite: Radio-Television 261. SCHOOLEY.

365. **Radio News.** News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. ½ unit. Prerequisite: Journalism 211. CRAMER.

366. **Advanced Radio and Television Practices, I.** Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. **Advanced Radio and Television Practices, II.** Continuation of Radio-Television 366. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. **Radio and Television Regulation.** Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. ½ unit. SCHOOLEY.

RECREATION AND MUNICIPAL PARK ADMINISTRATION

The Department of Recreation and Municipal Park Administration offers a program of graduate study leading to the Master of Science in Recreation. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in recreation, see page 280.) This program primarily prepares leaders, supervisors, administrators, teachers, and research workers in community recreation, but it also offers opportunities for preparation in the related fields of park administration, therapeutic recreation and rehabilitation, outdoor recreation, and college union administration, as well as recreation work with private agencies, business and industry, commercial recreation enterprise, etc.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last sixty semester hours; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Requirements for this degree are eight units including (1) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science, psychology, social work, and sociology; (2) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (3) registration in and satisfactory completion of Recreation 490, without credit; (4) presentation of an acceptable thesis in recreation, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

GRADUATE FACULTY

Professors: C. K. BRIGHTBILL (Head of Department), A. V. SAPORA.

Associate Professor: H. E. WEAVER.

Assistant Professors: M. VIRGINIA FRYE, E. H. STOREY.

Lecturers: R. E. OWENS, R. W. RUHE.

COURSES FOR GRADUATES

401. **Foundations of Recreation.** Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. 1 unit. Prerequisite: Recreation 176 or equivalent. BRIGHTBILL.

402. **Recreation Administration.** Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent. BRIGHTBILL.

403. **Evaluation of Recreation Resources and Programs.** Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; and research in the field of recreation. 1 unit. Prerequisite: Recreation 176 or 375 or equivalent; a course in tests and measurements or statistics. SAPORA.

404. **Outdoor Education and Recreation.** Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. WEAVER.

490. **Seminar.** Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. No credit. STAFF.

493. **Special Projects.** Independent research on special projects. Open only to students majoring in recreation. ½ to 2 units. Prerequisite: Recreation 403 or equivalent. STAFF.

499. **Thesis Research.** Preparation of theses in recreation. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. **Introduction to Administration.** Organization of public and private agency programs, leadership, facilities and services, and introduction to recreation administration. ½ or 1 unit. Prerequisite: Recreation 176. RUHE, SAPORA.

385. **Park Management.** An intensive study of the principles, practices, and problems involved in managing public park systems. Designed to provide a professional background including the history of parks, organization, planning, examination of facility design and layout, maintenance, finance, and operation of park systems. ½ or 1 unit. Prerequisite: Landscaping Architecture 235, Urban Planning 372, Political Science 305, Recreation 278 and 279, or equivalent. OWENS, RUHE.

395. **Recreational Use of Public Lands.** A study of lands in the public domain, and their historical, current, and potential use for outdoor recreation. It includes: an analysis of land, woods, and water in the public domain; the demand for outdoor recreation; multiple use concept of natural resources; functions and policies of federal and state governments and their agencies; the economics of outdoor recreation; and the future of outdoor recreation in America. ½ or 1 unit. Prerequisite: Recreation 176, Geography 214, and Economics 108 or consent of instructor. STOREY.

RUSSIAN LANGUAGE AND AREA STUDIES

Graduate programs in Russian language and area studies are offered by the Center for Russian Language and Area Studies in cooperation with various departments.

Minor for the Master's Degree. A candidate for the master's degree who elects Russian language and area studies as a minor must earn at least two units of graduate credit in courses chosen from the following: Anthropology 381, 382; Economics 312; Geography 353, 495; History 320, 321, 327, 328, 419; Law 369; Political Science 335, 383, 435; Russian 309, 310, 312, 321, 322, 323, 324, 325, 332, 333, 405, 410, 412, 413, 416, 417, 421, 423; Sociology 350, 450. The courses chosen must be in at least two departments.

Minor for the Doctor of Philosophy Degree. A doctoral candidate who elects Russian language and area studies as a minor must demonstrate a reading command of Russian as tested by examination or by completion of Russian 104 or 401 with a grade of A or B, and in addition must earn at least four units of graduate credit in courses chosen from the list given just above. The four units must include courses from at least two departments outside of, and may at the same time include up to one unit from within, the department offering the candidate's major.

Certificate of Graduate Specialization in Russian Language and Area Studies. This certificate is awarded by the Graduate College and the Center for Russian Language and Area Studies. It is for persons with the baccalaureate who are enrolled in advanced studies in any discipline and who wish at the same time to gain a knowledge of the Russian area and language. The requirements are: (1) A good command of written and spoken Russian, as determined by special examinations, or a grade of A or B in Russian 104 or 401. (2) At least six graduate units relating to Russia, distributed among at least three of the departments represented in the program (anthropology, economics, geography, history, law, political science, Russian and sociology) other than the student's own major department. (For courses, see above.) If the student's major department is one of these eight he may count, as part of his six units, up to one unit from within his major department. (3) A special essay based largely on Russian sources, which must meet, at the minimum, the standard normally required in a master's thesis. The student may submit, in fufillment of this requirement, a copy of his master's thesis or doctoral dissertation.

The adviser for the graduate minors and the Certificate is Professor Ralph T. Fisher, Jr., Director, Center for Russian Language and Area Studies, 1207 West Oregon Street, Urbana.

GRADUATE FACULTY

Professors: R. T. Fisher, Jr. (Director of Center), J. D. Fellmann, D. R. Hodgman, E. G. Lewis, L. R. Micklesen, D. B. Shimkin, A. Vucinich.

Associate Professors: Tatjana Cizevska, A. Kaspin, K. Klein, T. Pachmuss, V. Terras.

Assistant Professors: F. M. Gottheil, J. F. Hough, H. H. Kaplan, P. B. Maggs, C. Uszynski.

SLAVIC LANGUAGES AND LITERATURES

(Including Russian, Serbo-Croatian, and Ukrainian)

The Department of Slavic Languages and Literatures offers graduate work leading to the Master of Arts in Russian, Master of Arts in the Teaching of Russian, and Doctor of Philosophy in Russian.

Students with a minimum grade-point average of 4.0 are regularly admitted to graduate courses, subject to fulfillment of other prerequisites. Students with a grade-point average between 3.5 and 3.99 are admitted upon approval of the department.

Students electing Russian as a major subject should have had the equivalent of at least four years of Russian in college, including practical work in the use of the language and an advanced course in literature.

Students choosing Russian as a minor subject should consult the department.

Master of Arts in Russian. In addition to fulfilling the general requirements of the Graduate College, candidates must pass both a written and an oral examination. Students may major in literature or linguistics and may offer a minor. Students majoring in literature must present at least two courses in linguistics; those majoring in linguistics must present at least two courses in literature, and in addition, some training in another Slavic language.

Master of Arts in the Teaching of Russian. Candidates for this degree must earn four units in Russian, including a minimum of two units in 400 courses; Educational Psychology 311 and 312; one unit in History and Philosophy of Education 301, 302, 303, or 304; and two units of electives selected with the approval of the adviser.

Doctor of Philosophy in Russian. All candidates for this degree must fulfill the general requirements of the Graduate College and must have a reading knowledge of French and German. A student may major in literature or linguistics, but must offer a minor, preferably in another language or literature, comparative literature, or linguistics. Those students majoring in literature must present at least four courses in linguistics, as well as training in another Slavic language; students majoring in linguistics must present at least four courses in literature, along with some training in two other Slavic languages.

GRADUATE FACULTY

Professor: L. R. Micklesen (Head of Department).

Associate Professors: Tatjana Cizevska, A. Kaspin, K. Klein, Temira Pachmuss, V. Terras.

Russian

COURSES FOR GRADUATES

400. **Beginning Russian for Graduate Students.** Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit.

401. **Readings in Russian for Graduate Students.** Grammar, vocabulary, general and special readings. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit. Prerequisite: Russian 400 or equivalent.

405. **Old Church Slavonic.** Analysis of grammar, reading of texts, discussion of development of the Slavic languages. 1 unit. Cizevska.

406. **Russian Morphology.** A survey of the various parts of speech of modern standard literary Russian with special emphasis on the nominal and verbal systems. 1 unit.

407. **Russian Syntax.** A survey of historical and contemporary Russian syntax. 1 unit. Prerequisite: Russian 406 or consent of instructor.

410. **Literature of the Eleventh to the Sixteenth Century.** Reading of texts. Historical and literary background of the period. 1 unit. Cizevska.

412. **Literature of the Seventeenth and Eighteenth Centuries.** Reading of texts. Historical and literary background of the period. 1 unit. Terras.

413. **Modern Russian Drama.** A study of the Russian theatre from the eighteenth to the twentieth century. Plays by Russian authors are examined against the

background of Russian and Western dramatic theories. 1 unit. Prerequisite: Russian 322 and 324.

414. **Pushkin.** The age of Pushkin; Pushkin's works in historical and comparative perspective; textual criticism, linguistic and structural analysis, intellectual interpretation, and aesthetic evaluation. 1 unit. Prerequisite: Russian 321.

415. **Dostoevsky.** Dostoevsky: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Russian 323.

416. **Studies in Russian Criticism.** 1 unit. Prerequisite: Russian 322 and 324.

417. **History of the Russian Language.** 1 unit. Prerequisite: Russian 405.

418. **Oral Poetry and Slavic Poetics.** Linguistic material and poetic form. Oral poetry in its genres, motifs, and themes; their unity and diversity in the cultural history of Slavic peoples; the impact of oral poetry on literary tradition. 1 unit.

419. **Tolstoy.** Tolstoy: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Russian 322.

420. **Chekhov.** Chekhov: Historical background; textual criticism; structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Russian 324.

421. **Seminar in the Russian Novel.** Dostoevsky, Tolstoy, nineteenth-century novel, twentieth-century novel. Course may be repeated for credit not to exceed three units. 1 unit. Prerequisite: Russian 322 and 324.

423. **Seminar in Russian Poetry.** Pushkin, narrative verse, lyric verse, symbolism. Course may be repeated for credit not to exceed three units. 1 unit. Prerequisite: Russian 322, 324, or consent of instructor.

460. **Comparative Slavic Phonology.** The phonological structure of Common Slavic at the time of dissolution of the primitive Slavic community. The characteristic tendencies in the evolution of sound and prosodic systems in the East, West, and South Slavic languages groups. The phonemic patterns of single modern Slavic languages, outlines as a basis for a typological classification of Slavic languages. 1 unit. Prerequisite: Slavic 380.

491. **Individual Topics.** ¼ to 2 units. Prerequisite: Graduate standing with a major or minor in Russian.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Russian Phonetics and Diction.** Theoretical and practical work on pronunciation and intonation in Russian, with special attention to the problems of teachers. ½ unit. Prerequisite: Russian 212 or consent of instructor.

309. **Russian Literature in Translation, I.** Survey of Russian literature from the Kievan period to Turgenev; cultural and historical background of the period. No knowledge of the Russian language is required. ¾ unit.

310. **Russian Literature in Translation, II.** Survey of Russian literature from Dostoevsky to Symbolism; cultural and historical background of the period. No knowledge of the Russian language is required. ¾ unit.

311. **Advanced Russian Conversation.** Practice in free conversation with a native speaker. ¼ unit. Prerequisite: Three years of college Russian, including Russian 211 and 212, or consent of instructor.

312. **Soviet Literature in Translation.** Survey of Russian literature since the 1917 Revolution; cultural and historical background of the period. No knowledge of the Russian language is required. ½ unit.

313. **Advanced Russian Composition.** Practice in advanced composition and study of advanced problems of grammar, syntax, and style. ¼ unit. Prerequisite: Three years of college Russian, including Russian 213 and 214, or consent of instructor.

321. **Readings in Russian Literature: Pushkin, Lermontov, Gogol.** Representative works of the period 1820-1850. Historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202 or consent of instructor.

322. **Readings in Russian Literature: Dostoevsky and Tolstoy.** Representative works in their historical and cultural contexts. ¾ unit. Prerequisite: Russian 201 and 202 or consent of instructor.

323. **Readings in Russian Literature: Turgenev, Goncharov, Ostrovsky.** Representative works of the period 1850-1880. Historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

324. **Readings in Russian Literature: Chekhov, Gorky, Blok.** Representative works of the period 1880-1917. Historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202 or consent of instructor.

325. **Readings in Soviet Literature.** Representative works of Russian literature since 1917: Mayakovsky, Leonov, Sholokhov, and others; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 202 or consent of instructor.

331. **Slavic Civilization and Literatures.** A survey of Slavic institutions and life as reflected in Slavic literatures other than Russian, Polish, Czech, Ukrainian, etc., and their connection with Russian traditions. ¾ unit. Prerequisite: Reading knowledge of Russian or one other Slavic language or consent of instructor. TERRAS.

332. **Traditions of Russian Literature and Thought.** The rise and development of Russian social and philosophical thought in the nineteenth century and its impact on literature. ¾ unit. Prerequisite: Consent of instructor.

333. **The Russian Short Novel.** Theory and techniques of the *povest'* and related forms in the nineteenth and twentieth centuries. S; ½ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

380. **Introduction to Slavic Linguistics.** Same as Linguistics 380. Changes in phonology and morphology from Indo-European to Common Slavic. Geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit. MICKLESEN.

382. **Language Laboratory Techniques.** Same as French, German, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. S; ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

Serbo-Croatian

COURSES FOR GRADUATES AND UNDERGRADUATES

392. **The Structure of Serbo-Croatian.** Serbo-Croatian phonology, morphology, and syntax presented against a thorough knowledge of Russian as a background and basis for comparison of the East Slavic and South Slavic branches of the Slavic languages. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Russian 104.

394. **Serbo-Croatian Literature.** Analysis of selected works with special reference to Slavic oral poetry. ¾ unit. Prerequisite: Serbo-Croatian 392 or consent of instructor.

Ukrainian

COURSES FOR GRADUATES AND UNDERGRADUATES

396. The Structure of Ukrainian. Ukrainian phonology, morphology, and syntax presented with Russian as a background and basis for comparison of these two East Slavic languages. ¾ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Russian 104 or equivalent.

398. Readings in Ukrainian Literature. Representative works of Ukrainian literature and their historical and cultural background. ¾ unit. Offered in 1965-1966 and in alternate years. Prerequisite: Ukrainian 396 or consent of instructor.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including anthropology, economics, geography, history, philosophy, political science, psychology, social work, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work required for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor J. B. Casagrande, 137b Davenport Hall. The general adviser for this degree is Professor George Manner, 321 Lincoln Hall.

Master of Arts in the Teaching of Social Studies. Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. The courses in the social studies should be selected from not more than three of the following fields: history (two units required), economics, geography, philosophy, political science, and sociology. The courses in education must include Educational Psychology 311, 312, and Secondary and Continuing Education 456, and two of the following: History and Philosophy of Education 301, 302, 303, and 304. The courses in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

The adviser for candidates for this degree is Professor Charles E. Nowell, 310 Armory.

SOCIAL WORK

The Jane Addams Graduate School of Social Work offers two years of graduate professional study leading to the Master of Social Work. Although the basic curriculum of the school is the same for all students, there are opportunities for specialization in casework and group work. Students specializing in group work have their classes on the campus of the University of Illinois at the Medical Center, Chicago, and field placements in group work agencies in the city. Those specializing in casework may have classes on either the Urbana or Chicago campus, with field placements in selected agencies nearby.

The School has established an admissions committee which is responsible for reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. The applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthful relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

The School is compelled to limit enrollment to the number of field work placements available.

Application must be made to the Jane Addams Graduate School of Social Work. The special catalog issued by the School may be obtained by writing to the Director, Jane Addams Graduate School of Social Work, University of Illinois, 1207 West Oregon Street, Urbana 61801.

GRADUATE FACULTY

Professors: M. P. Hale (Director of the School of Social Work), Jennette R. Gruener, Florence L. Poole, W. P. Simon, D. E. Tanenbaum.

Associate Professors: I. Canter, Margaret G. Holden, D. E. Lathrope, J. E. McDonald, Mary E. Sullivan, M. A. Taber, L. Jane Wille.

Assistant Professors: J. J. Alderson, Martha Copeland, Lela B. Costin, M. E. Springer, A. J. Vattano.

COURSES FOR GRADUATES

421. **Social Work Methods, I.** Principles and practice of social work integrating classroom and field instruction. Sections A1 and A2 are required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. 2 to 4 units.

Section A1. Community Organization. Emphasis is on the community organization component of social work practice in various settings. Beginning knowledge and illustrative elements of the practice of community organization at the neighborhood, community, county, metropolitan region, state, national and international levels. ½ unit.

Section A2. Research. Objectives and methods of social work research. Basic principles of designing studies, evaluation of methods of collecting data, construction of schedules, analysis and presentation of results. Prerequisite:

A course in elementary statistical method. In lieu of this, a noncredit course in statistical method may be taken concurrently. No credit.

Section B1. Social Casework. Consideration of the principles of social work in the practice of social casework. Through discussion of case material from various settings and from his own field experiences, the student is helped to understand social casework method and to use this in helping the client. ½ unit.

Section C1. Social Group Work. Consideration of the principles of social work in the practice of social group work. Dynamics of the group process and the meaning of program activities. The student is helped to use this understanding to enable the individual and the group to develop a capacity for creative relationships. ½ unit.

Sections B2 and C2. Field Instruction. The student is assigned to a social agency in which, under the supervision of a qualified field instructor, he has responsibility for carrying selected cases or for direct work with groups. Instruction is based on the student's own practice and is designed to help him develop skill in social work methods. 1 unit.

422. **Social Work Methods, II.** Continuation of Social Work 421. More extensive analysis and application of the principles of casework and group work. Sections A1 and A2 are required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. 2 to 4 units. Prerequisite; Social Work 421.

Section A1. Generic Principles: Casework and Group Work. Study of principles underlying similarities and differences in giving and taking help within casework and group work relationships. For the student who is concentrating on casework practice, the focus is on working with group situations inherent in casework settings. For the group worker, the focus is on concepts concerning professional help in individual relationships and on the responsible part the group worker can assume within these relationships. No. credit.

Section A2. Research. Continuation of Social Work 421, Section A2. Critical analysis of research studies in human growth and development, social work methods, and social welfare services. ½ unit.

Section B1. Social Casework. Continuation of Social Work 421, Section B1. Designed to help the student increase his knowledge and improve his skill in the practice of social casework. ½ unit.

Section C1. Social Group Work. Continuation of Social Work 421, Section C1. Designed to help the student increase his knowledge and improve his skill in the practice of social group work. ½ unit.

Sections B2 and C2. Field Instruction. Continuation of the first semester of field instruction. 1 unit.

423. **Social Work Methods, III.** Emphasis is on the student's understanding and skill in social work with broader consideration of practice in various settings. Section A1 is required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. 2 to 4 units. Prerequisite: Social Work 422.

Section A1. Social Work Practice. Social work method in different settings. Ways of determining the nature and content of social work services in various settings; methods of developing effective working relationships in multidiscipline settings. Consideration of content specific to various kinds of agencies in which social work is practiced. ½ unit.

Section B1. Social Casework. Continuation of Social Work 422, Section B1, with increased emphasis on the generic, diagnostic, and differential treatment aspects of social casework. Application of the case study method to a variety of settings in which social casework is practiced. ½ unit.

Section C1. Social Group Work. Use of the social group work method with particular attention to the social group work process as related to variations in type, size, and purpose of the group. Advanced material in using program content with the group, and the role of the group worker in planning intra-agency service. ½ unit.

Sections B2 and C2. Field Instruction. Based on the student's own practice in a setting related to his field of specialization. Emphasis is on enhancing the student's skill in practice. 1 unit.

424. **Social Work Methods, IV.** Continuation of Social Work 423. Section A1 is required of all students; Sections B1 and B2 of casework majors; Sections C1 and C2 of group work majors. 2 to 4 units. Prerequisite: Social Work 423.
Section A1. Social Work Practice. Social work practice in areas of supervision, consultation, and administration. Emphasis for the casework student is on the understanding of the worker's role in consultation, policy-making, program planning, and interpretation. Emphasis for the group work student is on supervisory and administrative practice with special reference to supervision of volunteer leaders. ½ unit.

Section B1. Social Casework. Continuation of Social Work 423, Section B1. Learning experiences arranged to assist the student to a greater integration of the philosophy, concepts, and principles in social casework. ½ unit.
Section C1. Social Group Work. Continuation of Social Work 423, Section C1. Further discussion of principles and practice in social group work with emphasis on the student's ability to present, analyze, and evaluate material from his own practice. ½ unit.

Sections B2 and C2. Field Instruction. Continuation of the third semester of field instruction. 1 unit.

451. **Dynamics of Human Development, I.** Designed to provide the student with an understanding of normal physical, emotional, and social growth throughout the life cycle. Relevant material is included from the fields of medicine, psychology, psychiatry, and cultural anthropology. 1 to 2 units.

453. **Dynamics of Human Development, II.** Understanding of deviations from normal physiololgical functioning as demonstrated in major chronic disease processes. Interrelationship of physical, emotional, and social aspects of causation of disease and implications for the patient, family, and community. Discussion of the role of the social worker in collaboration with other disciplines concerned with provision of medical and rehabilitative services. 1 to 2 units. Prerequisite: Social Work 451.

454. **Dynamics of Human Development, III.** Concepts and theories used in social work to understand the nature and causes of emotional pathology in social functioning. 1 to 2 units. Prerequisite: Social Work 451.

461. **Special Studies in Social Work, I.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. 1 to 2 units.

462. **Special Studies in Social Work, II.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. 1 to 2 units.

481. **Social Welfare Organization, I.** Analysis of social welfare as part of the social structure, followed by a historical study of its development, aimed at accounting for the present position of social work and social welfare in American culture. The emergence of specialized services, the contribution of private philanthropy, the expansion of public responsibility, the interrelations of social welfare with other aspects of the culture and historical developments. 1 to 2 units.

482. **Social Welfare Organization, II.** Principles and content of public and private programs directly affecting family welfare, particularly income maintenance

and related services. Consideration of the social insurances, public assistance, employment services, labor standards, protective legislation, and community-sponsored family service programs. Focus is on basic premises, content, objectives, and adequacy of each program as a means of providing protection against economic want, and the maintenance and restoration of the social functioning of individuals and families. 1 to 2 units. Prerequisite: Social Work 481.

483. **Social Welfare Organization, III.** Examination of proposals to strengthen programs and services in each of the national, state, and community social welfare programs in the light of evolving needs and changing resources. Consideration of public health, medical care, health insurance, chronic illness and disability, rehabilitation services, mental health care, services for children, urban renewal, programs for the aging, correctional services, and informal education and leisure-time programs. 1 to 2 units. Prerequisite: Social Work 482.

484. **Social Welfare Organization, IV.** Analysis of organizational patterns and of the administrative process. Study of the structures of international, national, state, and local public and private agencies to reveal their functions and interrelationships. Review of the administrative process through examination of policy formulation, the executive function, organization, coordination, field services, personnel, budgeting, and public relations. Social action and the legislative process, and current developments and issues in the area of social work are examined. 1 to 2 units. Prerequisite: Social Work 483.

491. **Research Seminar.** Seminar for students preparing research projects, either in groups or individually. Experience in the application of research methods to current social work problems. 0 to 2 units. Prerequisite: Social Work 421 and 422, Section A2.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Introduction to Social Casework.** Behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of these upon the contacts of social caseworkers with individuals and families. Attention is given to case records selected from social casework practice in public assistance and other community agencies. ½ unit. Prerequisite: Consent of instructor.

316. **Social Services for Children.** Unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard-setting in social services for children. ½ or 1 unit. Prerequisite: A major in any of the social sciences, education, recreation, speech correction; consent of instructor.

333. **Introduction to Social Group Work.** Background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. ½ unit. Prerequisite: Introductory courses in sociology, psychology, and social sciences; consent of instructor.

SOCIOLOGY

The Department of Sociology offers graduate work leading to the Master of Arts and Doctor of Philosophy in Sociology.

In order to be considered for admission, students intending to elect sociology as their major must offer:

(1) A grade-point average of at least 3.75 (applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis);

(2) A minimum of nine semester hours of undergraduate work in sociology;

(3) One or more courses in quantitative research methods in sociology;

(4) Fifteen semester hours in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

The prerequisite for a graduate minor in sociology is six hours of undergraduate work in sociology.

Master of Arts. The requirements for the Master of Arts in Sociology are as follows: (1) Eight units approved by the adviser, including Sociology 185, *either* Sociology 385 or Sociology 386, and Sociology 400, and no more than one unit of thesis credit. (2) Passing the master's comprehensive examination. This examination is given once each semester and summer session on dates announced in advance by the department. (3) Preparation of an acceptable thesis which embodies the results of an original research project. (4) Passing an oral examination, primarily on the thesis, conducted by the student's advisory committee.

Doctor of Philosophy. The applicant who has obtained his Master of Arts from the University of Illinois is judged as to his qualifications for further advanced work on the basis of his academic record and his performance on the master's comprehensive examination. The applicant whose previous graduate work was done elsewhere may be admitted on a provisional basis.

The student's program of study for the doctorate is selected in consultation with the adviser. It must include Sociology 385, 386, and 387, or equivalent.

GRADUATE FACULTY

Professors: D. Glaser (Head of Department), B. Farber, C. L. Folse, J. R. Gusfield, J. E. Hulett, Jr., B. Karsh, D. E. Lindstrom, L. Schneider, A. Vucinich.

Associate Professors: D. Bordua, H. M. Johnson, B. Lazerwitz (on leave 1965-1967), Rita Simon, H. Y. Tien.

Assistant Professors: J. P. Clark, K. W. Dickman, J. L. Simmons, R. F. Tomasson.

Instructors: M. Lewis, G. McCall, W. Phillips.

COURSES FOR GRADUATES

400. **General Sociology.** Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. 1 unit. Schneider.

407. **Population Studies and Demographic Analysis.** Same as Rural Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. Folse.

409. **Psychological Scaling.** Same as Psychology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology,

and social psychology. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Psychology 307. TUCKER.

411. **Sociology of Science.** Social factors in the origin of broad theoretical orientations in science, such as the mechanistic doctrine, vitalism, historicism, atomism, holism, relativism, and indeterminism; social effects of these orientations; the social origin of scientists; ethos of science; the relationship of science to culture change; the variety and nature of scientific institutions. 1 unit. Prerequisite: Sociology 311 or consent of instructor.

412. **Seminar on Social and Cultural Relations of Personality.** Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. 1 unit. HULETT.

414. **Seminar on Social Interaction.** Same as Communications 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

417. **Seminar in the Sociology of Law.** Review and analysis of selected areas of theory and research in the sociology of law. The focus will vary from year to year. Topics covered in different years will include such areas as civil litigation and the civil courts, police operations and the sociology of law and order, sociological theories of justice and the operations of legal agencies. Students should consult the instructor about the area to be covered in a particular semester. 1 unit. Prerequisite: Sociology 317. BORDUA.

418. **Seminar in Industrial and Economic Sociology.** Same as Labor and Industrial Relations 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Sociology or Labor and Industrial Relations 318 or consent of instructor. KARSH, PHILLIPS.

421. **Seminar on Research in Marriage and Family Life.** Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. 1 unit. Prerequisite: Consent of instructor. FARBER.

422. **Theory of Social Groups.** A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. 1 unit.

424. **Seminar in Penology.** Sociological analysis of law enforcement, adjudication, and the rehabilitation of criminals, with emphasis on direct contact with agencies having these functions, and the design of research projects relevant to their problems. 1 unit. Prerequisite: Sociology 331 or equivalent. GLASER.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology.

431. **Seminar in Criminology.** Analysis of selected research problems on the development of criminological thought and the investigation of the causes of crime. 1 unit. Prerequisite: Sociology 331 or equivalent. BORDUA, CLARK, GLASER.

432. **Critique of Research in Juvenile Delinquency.** Analysis of major investigations into the causes, treatment, and prevention of delinquency and criminality

in youth. 1 unit. Prerequisite: Sociology 331 or consent of instructor; Sociology 431 is recommended. BORDUA, CLARK.

435. **Field Instruction and Research in Penal Sociology.** Problems of designing and conducting criminological research in penal institutions; supervised training and practice in the functions of sociologists in prisons. Conducted only in the summer with the first and eighth weeks spent on campus; six weeks are spent in the offices of sociologists in prisons. Application for admission to this course must be made in April prior to the summer session in which enrollment is desired. S; 1 unit. Prerequisite: Sociology 324 and 331 or equivalent; consent of instructor; passing routine employment clearance procedures (including fingerprinting) required by the prison. GLASER.

440. **Political Sociology.** An analysis of the impact of social cleavages and cohesion on the operation of political institutions and movements; the place of conflict and power in sociological theory; composition and behavior of power elites; participation in political associations; national and local power structure; social functions of electoral behavior; modern national and mass political movements. 1 unit. Prerequisite: Sociology 400 or consent of instructor. GUSFIELD.

444. **Seminar in Public Opinion.** Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

450. **Problems of Soviet Society in Transition.** This seminar examines certain major problems inherent in directed social change from an agricultural to an industrial system under a totalitarian regime of the Soviet type. Attention is focused on such areas as the different phases of the revolutionary process, inconsistencies between ideological premises and the demands of industrialism, the unanticipated consequences of social change, the simultaneous impact upon the social system of industrialism and totalitarianism, and implications of the Soviet experience for other countries. 1 unit. Prerequisite: Consent of instructor. VUCINICH.

473. **The Community in Modern American Society.** Comparative analysis of community life as it is influenced by institutional trends of the larger society. 1 unit. Prerequisite: Sociology 400.

476. **Urban Communities and Urbanization.** Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. 1 unit.

477. **Rural Community Organization and Development.** Same as Rural Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of rural community organization; the process of community development as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

480. **Sociological Theory and Method.** This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. 1 unit.

482. **Recent Developments in Sociology.** Intensive study of selected topics based on contemporary works of major importance in the development of sociological theory. 1 unit. Students may reregister for a total of two units credit.

485. **The Sampling of Human Populations and Social Organizations.** Same as Psychology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples,

stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

486. Seminar on Experimental Sociology. The logic, design, and analysis of laboratory and field experiments, with special emphasis on the controlled investigation of social processes. 1 unit. Prerequisite: Sociology 385 or equivalent, or consent of instructor.

487. Special Problems in Rural Sociology. Same as Rural Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

490. Individual Topics in Sociology. Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. ½ to 2 units. STAFF.

494. Multivariate Analysis in Psychology and Education. Same as Educational Psychology and Psychology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. KAISER, TUCKER.

495. Computer Applications to Sociological Investigations. Research designs and computer procedures for the analysis of sociological data, including data on social status relations and institutional patterns; application to sociological materials using regression analysis, factor analysis, linear programming, and the theory of games. ¾ unit. Prerequisite: Sociology 385 or equivalent experience in statistics. DICKMAN.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Social Systems and Institutions. An advanced discussion of general principles and concepts in sociology; among the topics discussed are culture, social structure, socialization, primary groups, social stratification; their application to problems in political sociology, industrialization, race relations, religion, and delinquency; the bearing of these upon larger problems of social order and social change. Designed for advanced undergraduate majors in sociology and other social sciences and for graduate students in sociology without adequate preparation for graduate work. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science or consent of instructor.

311. Sociology of Intellectual Life. A comparative sociological analysis of the development of the intelligentsia in Europe and elsewhere. Central concerns include the institutional supports for intellectual work under various social and cultural conditions, the social origin and status of different types of intellectuals, the formation of distinct scientific traditions, and the relationships of these traditions to ideology, literature, and philosophy. This involves a critical scrutiny of the theoretical literature and methodology of the sociology of knowledge. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. VUCINICH.

315. Sociology of Education. Same as History and Philosophy of Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in

countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

317. **Sociology of Law.** A general treatment of the social origins and consequences of law and legal process. Special emphasis is placed on problems of legal change, on the structure and functioning of legal sanctions. Some attention is paid to law and law-like phenomena in other societies, including primitive societies, but the main focus is on American society. ½ or 1 unit. Prerequisite: Sociology 100. BORDUA.

318. **Industry and Society.** Same as Labor and Industrial Relations 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following. Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH, PHILLIPS.

320. **Social Roles.** Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. HULETT.

321. **Family, Kinship, and Crisis.** An analysis of family and kinship, with major concentration on the American family. Implications of the American kinship system for trends in courtship and mate selection, interaction among kin, and other areas of family life are investigated. Family crisis is used as a focus for analysis of family organization. ½ or 1 unit. Prerequisite: Sociology 185. FARBER.

322. **Sociology of Bureaucracy and Administrative Organization.** An analysis of major types of formal organizations from the viewpoint of generalized theories of organization and of substantive theories of bureaucratization and rationalization. Among the formal organizations studied are business enterprises and unions, educational and medical institutions, and non-voluntary organizations. The interrelations between bureaucracy, ideology, and social structure are particularly emphasized. ½ or 1 unit. Prerequisite: Nine hours of sociology including Sociology 300, or consent of instructor.

323. **The Small Social Group.** Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

324. **Penology.** Probation; parole; methods of institutional treatment. ½ or 1 unit. Prerequisite: Sociology 331. GLASER.

326. **Social Mobility and Class Structure.** An advanced course in social stratification, concerned with patterns, causes, and consequences of social mobility and immobility. Includes the analysis of rising and falling classes in industrial and developing countries and the circulation of political, social, and economic elites, as well as institutional sources of individual mobility. ½ or 1 unit. Prerequisite: Sociology 223 or consent of instructor.

329. **Comparative Family Institutions.** Cross-cultural analysis of family institutions, with special reference to vital and demographic backgrounds and with stress on property, authority, and handling of deviance, and relationship to religion, economy, and polity. ½ or 1 unit. Prerequisite: Sociology 185. FARBER, LEWIS.

331. **Criminology.** Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal

and cultural conditions. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. CLARK.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105. GUSFIELD.

343. **Social Change in Developing Areas.** Description and analysis of recent social and cultural changes occurring in new nations and developing economies. Special attention is given to problems of traditional social structure undergoing modernization. Social factors in economic growth, caste and class, nation-building, urbanization and population composition, education, family and religion. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or equivalent.

344. **Public Opinion.** Same as Communications 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. SIMON.

350. **Soviet Social Institutions.** This course analyzes the major social institutions of Soviet society. Special attention is paid to the structural consequences of Communist ideology, totalitarianism and industrialism, and to comparison with and implications for American society. The major areas covered are: population data and their sociological implications; history, values, and ideology; political institutions; economic institutions; social stratification and mobility; the nationalities; the family and education, communications and public opinion; socialized medicine. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. The prerequisite does not apply to majors and minors in Russian Language and Area Studies. VUCINICH.

360. **Sociology of the Professions.** This course examines the nature, position, functions, and growing importance of the major professions in the contemporary industrial (or industrializing) society. Particularly close attention is paid to the relationship between the social system and the various professional "communities," recruitment, professional socialization, and bureaucratic vs. independent practice. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology and one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Population and Social Ecology.** Same as Rural Sociology 370. Growth and trends in world population; and intensive analysis of growth components, spatial distribution, compositional characteristics, and trends in United States population. Stress is placed upon social and economic characteristics of the population and the utility and implications these have for students of social science. ¾ or 1 unit. Prerequisite: Sociology 185 or equivalent. FOLSE.

371. **Comparative Social Institutions.** This course examines, in a comparative perspective, some of the major institutional complexes of social systems, such as family and kinship structures, occupations, political institutions, and social stratification and mobility. Illustrative materials are drawn from a variety of societies, including primitive nonliterate societies and advanced industrial societies such as the United States, Germany, and the Soviet Union. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor.

372. **Social Aspects of Mass Communications.** Same as Communications and Journalism 372. Media structures related to cultural content and functions; problems of life and society as treated in mass-produced communications. ½ unit.

373. **Latin American Social Organizations and Institutions.** Analysis of contemporrary institutional and social class structures in Latin American communities and societies, and their relationship to certain religious and family patterns; the influence of past and present trends in urbanization, ecological organization, and population growth upon Latin American social systems and institutional organization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Sociology, Anthropology, Geography, Health Education, Physiology, or Zoology 369.

385. **Social Statistics, I.** Deals intensively with descriptive statistics, probability, statistical inference, and significance testing by means of both parametric and nonparametric tests, and the various measures of association. 1 unit. Prerequisite: Sociology 185 or Mathematics 122 or 123, or consent of instructor.

386. **Methods of Field Research.** Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. ½ or 1 unit. Prerequisite: Three hours in advanced courses in sociology or consent of instructor. SIMMONS.

387. **Social Statistics, II.** Treats analysis of variance, analysis of covariance, multiple and partial correlations, and complicated sampling procedures. A semester problem is developed which emphasizes integration and application of various statistical techniques to sociological problems. ¾ or 1 unit. Prerequisite: Sociology 385.

SPANISH, ITALIAN, AND PORTUGUESE

The Department of Spanish, Italian, and Portuguese offers work leading to the Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are Spanish linguistics, Spanish literature, Latin American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, or consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for any advanced degree in Spanish must possess or acquire a practical command of the language. For the Doctor of Philosophy, some knowledge of Latin and Italian or Portuguese is required. The Latin requirement may be met by taking a minimum of one semester of Latin while in residence for the degree. Parallel training in one or more other languages or literatures, such as English, French, German, Greek, Italian, Latin, and Portuguese, is desirable.

Master of Arts.

(1) *Spanish or Latin American Literature.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 311, 314, 331, or 332, 351, 352; (b) Spanish 405 and Spanish 415 or 417; two of Spanish 421, 422, 423, 424; one of Spanish 431, 432, 433, 434. The course program may be supplemented by courses from the doctoral list, or by courses totaling one unit in a minor and one unit in each of two minors.

(2) *Spanish Linguistics.* Minimum requirements are: (a) linguistics courses: Spanish 351, 352, 451, and 453; (b) literature, three and one-half units from Spanish 305, 306, 307, 308, 311, and 314, plus electives from the 400-level group; and (c) general linguistics: one and one-half units chosen from three courses among the 300-level offerings in linguistics.

Master of Arts in the Teaching of Spanish.

(1) Up to three units from any of the following not included in an undergraduate program: Spanish 305 and 306, or Spanish 307 and 308 (or both sequences), Spanish 311, 314, 331, 332, 351, 352, Linguistics 300; at least three units selected from: Spanish 415 or 417; Spanish 421, 422, 423, or 424; Spanish 431, 432, 433, or 434.

(2) Education, two units: Educational Psychology 311 and 312, and two of the following: History and Philosophy of Education 301, 302, 303, and 304.

The adviser for candidates for this degree is Professor Joseph S. Flores, 219 Lincoln Hall.

Doctor of Philosophy.

(1) *With Specialization in the Renaissance and Golden Age.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; Spanish 415 or 417; one of Spanish 421, 422, 423, 424; Spanish 425 or 426; Spanish 453; two seminars.

(2) *With Specialization in the Nineteenth and Twentieth Centuries.* The minimum requirements, in addition to those for the master's degree are: Spanish 411; two of Spanish 421, 422, 423, 424; Spanish 425 or 426; Spanish 453; two seminars.

(3) *With Specialization in Latin American Literature.* The minimum requirements, in addition to those for the master's degree, are: one of Spanish 421, 425, 426; three of Spanish 431, 432, 433, 434, 437, and 438; Spanish 453; two seminars; Portuguese 301 and 302, or 491.

(4) *With Specialization in Spanish Linguistics.* The minimum requirements, in addition to those for the master's degree, are: (a) linguistics: Spanish 452 and 454; (b) literature: Spanish 411; one seminar; (c) general linguistics: required as the minor.

Students working toward the Doctor of Philosophy are admitted with provisional departmental status until their performance in graduate work is judged acceptable for full departmental status by the department's graduate committee.

The department should be consulted on the selection of minors. Minors available within the department are Spanish linguistics, Italian, Portuguese, Spanish and Latin American literature. Other minors are other languages and literatures, history, philosophy, anthropology, linguistics, Latin American studies, and other closely allied subjects.

Candidates for an advanced degree in Italian or Portuguese should consult the department. Provisions are made to fit individual cases. In special cases, Spanish literature and linguistics may be used reversibly as major and one minor.

GRADUATE FACULTY

Professors: W. H. Shoemaker (Head of Department), J. H. D. Allen, J. O. Crosby, J. S. Flores, H. R. Kahane, L. Leal, M. A. Morínigo, Angelina R. Pietrangeli.

Assistant Professors: S. W. Baldwin, Jr., W. C. Blaylock, M. H. Forster, J. W. Kronik, D. P. Testa.

Spanish

COURSES FOR GRADUATES

405. **Spanish Bibliography.** An introduction to bibliographical method and to the principal bibliographical resources for the study of Spanish and Latin American literature. ½ unit. Allen.

411. **Spanish Literature in the Middle Ages.** 1 unit. Allen.

412. **Spanish Literature in the Middle Ages.** 1 unit. Allen.

415. **Spanish Literature in the Sixteenth Century.** 1 unit. Allen.

416. **Spanish Literature in the Sixteenth Century.** 1 unit. Allen.

417. **Seventeenth-Century Literature.** 1 unit. Crosby, Flores, Morínigo.

418. **Seminar in Seventeenth-Century Literature.** 1 unit. Prerequisite: Spanish 311 or 415 or 417. Crosby, Morínigo.

421. **Modern Spanish Novel and Essay.** 1 unit. Shoemaker.

422. **Contemporary Spanish Novel and Essay.** 1 unit. Shoemaker.

423. **Modern Spanish Drama.** 1 unit. Shoemaker.

424. **Contemporary Spanish Drama.** 1 unit. Shoemaker.

425. **Renaissance and Baroque Poetry In Spain.** 1 unit. Crosby.

426. **Spanish Poetry of the Nineteenth and Twentieth Centuries.** 1 unit. Pietrangeli.

431. **Spanish American Poetry: Middle America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

432. **Spanish American Poetry: South America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

433. **Spanish American Novel: Middle America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal.

434. **Spanish American Novel: South America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal.

435. **Seminar in Spanish American Poetry.** 1 unit. Prerequisite: Spanish 431 or 432. Forster.

436. **Seminar in Spanish American Novel.** 1 unit. Prerequisite: Spanish 433 or 434. Leal.

437. **Spanish American Drama.** 1 unit. Prerequisite: Spanish 307 or 308. Forster.

438. **Spanish American Essay.** 1 unit. Prerequisite: Spanish 307 or 308. Leal.

443. **Seminar in Galdós.** Research work in novelistic criticism. Prerequisite: Spanish 305 or 306 and 311 or 314; or Spanish 421 and 422. 1 unit. Shoemaker.

444. **Seminar in Spanish Realism and Naturalism.** Research work in nineteenth-century literary theory and practice in novel and drama. 1 unit. Prerequisite: Spanish 305 or 306 and 311 or 314; or Spanish 421 and 422. Shoemaker.

445. **Seminar in Twentieth-Century Spanish Literature.** 1 unit. Prerequisite: Spanish 421 or 422 or 423 or 424, or equivalent. Shoemaker.

451. **Survey of Current Research in Spanish Linguistics.** Present-day methods of comparative, historical, and structural linguistics as applied to Spanish. 1 unit. Kahane.

452. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin American linguistics. 1 unit. Kahane, Morínigo.

453. **History of the Spanish Language.** 1 unit. KAHANE, MORÍNIGO.

454. **Old Spanish.** 1 unit. KAHANE, MORÍNIGO.

471. **Teaching College Spanish.** A presentation of the problems of the teaching of Spanish and training in their solution, together with a study of procedures, methods, and laboratory techniques. No credit. FLORES.

491. **Special Topics in Spanish.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. ALLEN, CROSBY, KAHANE, LEAL, MORÍNIGO, SHOEMAKER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Romanticism and Realism in Nineteenth-Century Spanish Literature.** A study of representative authors and genres of the nineteenth century, with particular emphasis on the romantic drama and the realistic novel. ½ unit. Prerequisite: Spanish 222 or equivalent. KRONIK.

306. **The Generation of 1898.** A study of representative works of Baroja, Azorín, Unamuno, Maeztu, Valle Inclán, Benavente, A. Machado, and others. ½ unit. Prerequisite: Spanish 222 or equivalent. KRONIK.

307. **Spanish American Literature to 1888.** A study of the development of Spanish American literature from the sixteenth century through the end of the Romantic period. ½ unit. Prerequisite: Spanish 222 or equivalent. LEAL.

308. ***Modernismo* and Contemporary Spanish American Poetry.** A study of Spanish American poetry from 1888 to the present; some attention is given to *modernista* prose. ½ unit. Prerequisite: Spanish 222 or equivalent. FORSTER.

311. ***Don Quixote* and the Prose of the Golden Age.** Introduction to *Don Quixote*, to its relationship to other selected masterpieces of the Golden Age, and to the main currents and forms of Golden Age prose. ½ unit. Prerequisite: Spanish 305 or 306 or 307 or 308, or equivalent. CROSBY.

314. **Spanish Drama and Poetry of the Golden Age.** ½ unit. Prerequisite: Spanish 305 or 306 or 307 or 308, or equivalent. FLORES, MORÍNIGO.

331. **La Cultura Hispánica: España.** Either Spanish 331 or 332 is required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. MORÍNIGO.

332. **La Cultura Hispánica: Hispanoamérica.** Either Spanish 331 or 332 is required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. LEAL, MORÍNIGO.

351. **Phonetics.** ½ unit. Prerequisite: Spanish 222, or equivalent. FLORES.

352. **Syntax.** ½ unit. Prerequisite: Spanish 222, or equivalent. KAHANE.

371. **Spanish for Teachers.** A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 222, or equivalent. FLORES.

382. **Language Laboratory Techniques.** Same as French, German, and Russian 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

Italian

COURSES FOR GRADUATES

411. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** 1 unit. PIETRANGELI.

412. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** 1 unit. PIETRANGELI.

415. **Italian Literature of the Renaissance.** 1 unit. PIETRANGELI.

416. **Italian Literature of the Renaissance.** 1 unit. PIETRANGELI.

451. **History of the Italian Language.** 1 unit. KAHANE.

452. **Seminar in Italian Linguistics.** 1 unit. KAHANE.

491. **Special Topics in Italian.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for 300-level courses is Italian 101 and 102. Italian 103 and 104 are desirable.

311. **Dante: La Divina Commedia.** ½ unit. PIETRANGELI.

312. **Dante: La Divina Commedia.** Continuation of Italian 311. ½ unit. PIETRANGELI.

321. **Modern Italian Literature.** ½ unit. PIETRANGELI.

322. **Modern Italian Literature.** ½ unit. PIETRANGELI.

Portuguese

COURSES FOR GRADUATES

491. **Special Topics in Portuguese.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. ALLEN, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Brazilian Literature.** Survey of the contemporary Brazilian novel. ½ unit. Prerequisite: Portuguese 103 or equivalent. ALLEN.

302. **Introduction to Portuguese Literature.** Survey of the Golden Age of Portuguese. ½ unit. Prerequisite: Portuguese 103 or equivalent. ALLEN.

303. **Luso-Brazilian Civilization and Culture.** Lectures in English, and readings in English or Portuguese, in Brazilian geography, history, politics, sociology, economics, art, and literature from the Discovery to Independence, designed to afford a broad understanding of the origins of Luso-Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Spanish 104 or Portuguese 102 or equivalent, or consent of instructor. ALLEN.

304. **Contemporary Brazilian Civilization and Culture Since 1822.** Lectures in English, and readings in English or Portuguese, in Brazilian geography, history, politics, sociology, economics, art, and literature since Independence, designed to afford a broad understanding of contemporary civilization and culture. ½ or 1 unit. Prerequisite: Spanish 104 or Portuguese 102 or equivalent, or consent of instructor. ALLEN.

305. **Structure of Brazilian Portuguese: Phonology.** Phonetics and phonemics of modern Brazilian Portuguese. ½ unit. Prerequisite: Portuguese 104 or consent of instructor. ALLEN.

306. **Structure of Brazilian Portuguese: Morphology and Syntax.** Morphemics and syntax of modern Brazilian Portuguese. ½ unit. Prerequisite: Portuguese 305 or consent of instructor. ALLEN.

SPEECH AND THEATRE

The Department of Speech and Theatre offers courses leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

The admission requirement, in terms of grade-point average, is at least 3.5.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theatre, oral interpretation, speech and hearing science. They may also select a special curriculum in the teaching of speech.

For the Master of Science, students may take a special curriculum in speech correction.

For the Doctor of Philosophy, students may exercise one of four options: rhetoric and public address; the theatre; speech and hearing science; experimental phonetics.

In addition to meeting general regulations of the Graduate College, the Department of Speech and Theatre specifies the requirements listed below.

Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech, including these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theatre, and an advanced course in public speaking or discussion. A thesis may be required.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated.

Master of Arts in the Teaching of Speech. Candidates for the Master of Arts who are interested in public school teaching should meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each; Speech 322 and 423, one unit each; and education, two units, including the following: History and Philosophy of Education 304 and 305, one unit, and Educational Psychology 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of theatre: speech, four units, including Speech 361 or 362 or 366, 352, 451, 452; education, two units, including the following: History and Philosophy of Education 304, and 305, and Educational Psychology 311 and 312; electives, two units.

Master of Science in Speech Correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all the requirements may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 387, 475, 476, 481, 483, 484, 486, 488, 489, 491, 495; one unit from History and Philosophy of Education 304, and 305, and one unit from Educational Psychology 311 and 312; two units of electives. The electives may be in speech, in psychology, or, in exceptional cases, in other fields.

Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree in speech or theatre from an accredited institution.

GRADUATE FACULTY

Professors: K. R. Wallace (Head of Department), H. E. Gulley, M. T. Herrick, B. W. Hewitt, H. L. Mueller, R. Murphy, Marie H. Nichols, J. J. O'Neill, J. W. Scott, C. H. Shattuck.

Associate Professors: Mary H. Arbenz, J. J. Bateman, Clara M. Behringer, K. W. Broadrick, K. Burns, O. A. Dieter, Genevieve Richardson, T. M. Scheidel, W. L. Smalley, K. A. Windesheim.

Assistant Professors: A. J. Derbyshire, T. Herstand, F. L. Nasca, Elaine P. Paden, R. K. Simpson, T. O. Sloan, E. W. Stark, B. R. Works, W. R. Zemlin.

Instructors: Joan E. Good, H. A. Peterson, R. E. Tymchyshyn.

COURSES FOR GRADUATES

400. **Seminar in Dramatic Form and Structure.** Studies in the relationship of dramatic form and structure to the contemporary production of historical and modern plays. 1 unit. Prerequisite: Speech 361 and 362 or equivalent, and consent of instructor. Smalley.

403. **Seminar for Teachers of Speech.** Investigation of current principles, materials, and developments in the field of speech and of their relationship to the teacher. 1 unit. Burns.

411. **The Greek Tradition in Rhetoric and Oratory.** The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. 1 unit. Bateman.

412. **The Roman Tradition in Rhetoric and Oratory.** Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. 1 unit. Dieter.

420. **Quantitative Methods in Rhetorical Analysis.** An introduction to the principles, procedures, and tools of research used in the quantitative analysis of the oral communication situation, including the experimental designs and statistical methods applicable to rhetorical analysis, and the identification, control, and measurement of rhetorical variables. Students participate in planning, executing, and reporting a limited experimental project investigating some oral communication variable. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Introductory course in statistics; consent of instructor. Scheidel.

423. **The Rhetoric of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. 1 unit. Wallace.

430. **Contemporary Theories of Oral Communication.** Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Consent of instructor. Scheidel.

436. **Seminar in Public Discussion.** Investigation of special problems in public discussion. 1 unit. Offered in 1965-1966 and in alternate years. Murphy.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. 1 unit. Wallace.

441. **Historical Background of Oral Interpretation.** Historical survey of British and American theories of interpretation. 1 unit. Murphy.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. 1 unit. Prerequisite: Speech 441; consent of instructor. Sloan.

451. **Problems in Play Directing in the Educational Theatre.** Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. Behringer.

452. **Problems in Play Production in the Educational Theatre.** Study of the school auditoria and stages, stage machinery and equipment and their use, lighting

facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. BEHRINGER.

461. Advanced Theatre Techniques. Individual development of advanced techniques of acting and staging through supervised participation in public productions. S; ½ or 1 unit. Prerequisite: At least one semester of graduate study in the area of theatre; consent of head of the department and of instructor. HERSTAND.

463. Seminar in the History of Acting. Studies in the history and theory of the art of acting. 1 unit. Students may accumulate maximum credit of two units. Offered in 1965-1966 and in alternate years. SHATTUCK.

465. Seminar in Theatre Art. Studies in the aesthetics of the theatre. 1 unit. HEWITT.

466. The American Theatre Since 1900. Major developments in acting, production, playwriting, organization, and operation. 1 unit. HEWITT.

468. Seminar in Theatre History. Studies in the history of the theatre. 1 unit. HEWITT.

469. The Stage History of Classic English Plays. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor. SHATTUCK.

472. Psychoacoustics of Speech. Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

473. Seminar in Phonetics. Same as Linguistics 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor.

475. Experimental Phonetics, I. Same as Linguistics 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. Experimental Phonetics, II. Same as Linguistics 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. Measurement of Speech, I. Same as Linguistics 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. ZEMLIN.

478. Measurement of Speech, II. Same as Linguistics 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. ZEMLIN.

481. Seminar in Neuropathologies of Speech and Language. Advanced study of speech, vocal, and linguistic problems associated with cerebral palsy, aphasia, and mental retardation. 1 unit. Prerequisite: Consent of instructor.

482. Seminar in Stuttering. Principles, theories, and methods of clinical management of stuttering behavior in children and adults. 1 unit. Prerequisite: Speech 388.

483. Psychology of Speech and Hearing Disorders, I. Same as Psychology 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. Psychology of Speech and Hearing Disorders, II. Same as Psychology 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

486. Advanced Clinical Techniques in Speech and Hearing. Practice of advanced clinical therapy for speech and hearing disorders; semi-independent management of complex, difficult cases; participation in examination and analysis. ½ to 4 units. Prerequisite: Consent of instructor. O'NEILL, STAFF.

488. Diagnostic Procedures in Pathologies of Speech and Language. Study of diagnostic procedures used in the analysis of neuropathologies of speech and language and orofacial and laryngeal pathologies of speech. 1 unit. Prerequisite: Consent of instructor.

489. Seminar in Orofacial and Laryngeal Pathologies of Speech. Advanced study of speech and vocal problems associated with cleft palate, laryngeal dysfunctions and facial-maxillary disturbances. 1 unit. Prerequisite: Consent of instructor.

490. Medical Aspects of Speech Disorders and Audiology. Study of acute and chronic hearing and speech disorders traceable to disease of the ear and vocal mechanisms in relation to the techniques and philosophies utilized in a medically oriented environment. 1 unit. Prerequisite: Speech 385, 388, and 486. O'NEILL.

491. Seminar in Hearing Disorders. Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Speech 391. O'NEILL.

492. Advanced Audiology. Advanced study of rationale and development of principles associated with special techniques, procedures, and methods used in audiology. 1 unit. Prerequisite: Speech 395 and 397. STARK.

495. Special Problems. Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. 1 to 2 units. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 0 to 4 units. BATEMAN, BEHRINGER, DIETER, GULLEY, HEWITT, NICHOLS, MURPHY, O'NEILL, SCHEIDEL, SHATTUCK, SMALLEY, WALLACE, WINDESHEIM.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. General Phonetics. Same as Linguistics 301. Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit. PADEN.

307. The Art of the Screen: Narration. Same as Communications 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screeen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. The Art of the Screen: Exposition and Persuasion. Same as Communications 308. Critical study of the application of the eclectic principles of the screen

narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

311. **British Public Address.** Study of representative British speakers from the sixteenth century to the present. Lectures, reports, and papers. ½ or 1 unit. MURPHY.

312. **American Public Address.** Study of representative American speeches from the sixteenth century to the present. ½ or 1 unit. NICHOLS.

322. **Modern Rhetorical Theory.** Significant movements in the development of rhetorical theory in England, France, and America from 1700 to the present. ½ or 1 unit. BROADRICK, NICHOLS.

342. **Oral Interpretation of Poetry.** Analysis and oral presentation of literature representative of various poetic forms. ½ or 1 unit. Prerequisite: Speech 141. BURNS, SLOAN.

345. **Contemporary Approaches to Oral Interpretation.** Modern concepts underlying the relationship of interpretation to the reader's experience of literature; discussions, reports, oral interpretations of prose forms (including Chamber Theatre and Readers Theatre). ½ or 1 unit. Prerequisite: Speech 141 or consent of instructor. SLOAN.

351. **Styles of Acting for Period Plays.** Study and practice of traditional styles of acting in dramas by important playwrights representing major theatrical eras such as Sophocles, Aristophanes, Shakespeare, Racine, Moliere, Congreve, Wilde. Lectures, demonstrations, exercises, performance. ½ unit. Prerequisite: Speech 261 or consent of instructor. ARBENZ.

352. **Introduction to Modern Theatre Art.** Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. HEWITT.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

354. **Theatre for the Child Audience.** A study of the history, the objectives, and the techniques of play production for the child audience, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

355. **Advanced Play Directing.** A study of advanced directing techniques; styles of drama; specialized procedures. ½ or 1 unit. Prerequisite: Speech 255 or equivalent. BEHRINGER.

361. **History of the European Theatre to the Renaissance.** The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. SCOTT.

362. **History of the European Theatre from the Renaissance to 1900.** The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. SCOTT.

363. **Advanced Playwriting.** Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing the full-length play. ½ or 1 unit. Students may accumulate two units of credit. Prerequisite: Speech 236; consent of instructor. SMALLEY.

366. **Development of the American Theatre.** The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. HEWITT.

368. **History of Theatre Costume.** A survey of the history of costumes worn on the stage from the classical Greek period to the present. ½ or 1 unit. Prerequisite: Speech 361 and 362 or consent of instructor. RICHARDSON.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. ½ or 1 unit. Prerequisite: Speech 157 and two of the following: Speech 255, 352, 361, 362; or consent of instructor. WORKS.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. ½ or 1 unit. HERRICK.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. ½ or 1 unit. HERRICK.

375. **Speech Science.** Same as Linguistics 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Speech 301 or consent of instructor. ZEMLIN.

376. **Speech Science.** Same as Linguistics 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

383. **Development of Spoken Language.** A study of the development of verbal communication from the prelinguistic period to adulthood in the instance of the normal, physically handicapped, and mentally retarded. ½ or 1 unit. Prerequisite: Consent of instructor. O'NEILL.

385. **Speech Correction.** Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation and practice in clinical techniques are provided in the laboratory. ½ unit. Prerequisite: Ten hours of speech or consent of instructor. SIMPSON.

386. **Basic Diagnostic and Therapeutic Principles of Speech Correction.** Instruction and practice in the administration and interpretation of diagnostic tests; discussion and demonstration of clinical approaches used with speech disorders. ½ unit. Prerequisite: Speech 385; credit or concurrent registration in Speech 388. PETERSON.

387. **Practicum in Speech Diagnosis and Therapy.** Observation, practice, and research in diagnosis and therapy of speech disorders. ½ unit. Prerequisite: Speech 386; a grade-point average of at least 3.5; consent of instructor. PETERSON, STAFF.

388. **Speech Correction.** Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and glandular disorders. ½ or 1 unit. Prerequisite: Speech 385. SIMPSON.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. ½ or 1 unit. Prerequisite: Speech 301 and 375, or consent of instructor. STARK.

393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling; clinical and classroom practice with children and adults. ½ or 1 unit. Prerequisite: Speech 391; a grade-point average of at least 3.5.; consent of instructor. Required in the curriculum of teacher training in speech correction. NASCA.

395. **Audiometry and the Use of Hearing Aids.** Selective and diagnostic tests of hearing, the planning and conduct of hearing conservation programs, general problems involved in the use of hearing aids. ½ or 1 unit. Prerequisite: Speech 376. STARK.

396. **Differential Diagnosis of Hearing Disorders in Young Children.** Special tests and procedures for the measurement of residual hearing in young children;

the effects of complex peripheral and central auditory dysfunctions on communication training; the use of nonwearable amplifiers with young children; practice in clinical techniques. ½ or 1 unit. Prerequisite: Speech 391 and 395, or consent of instructor. STARK.

397. Measurement of Auditory Perception. Principles and methods of clinical assessment of auditory perception. Intensive study of measurement techniques for speech perception; applications with clinical clients; survey of current literature and research. ½ or 1 unit. Offered in 1965-1966 and in alternate years. Prerequisite: Speech 391. O'NEILL.

398. Practicum in Audiology. Observation, practice, and research in diagnosis and rehabilitation of auditory disorders. ½ unit. Prerequisite: Speech 393. STARK.

399. Experimental Design in Speech Disorders and Audiology. Review of current research issues: orientation to types of experimental designs and research methods used in speech disorders and audiology. ½ unit.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers work leading to the Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major must have had the equivalent of the undergraduate courses in mechanics usually required for a bachelor's degree in the curricula in the College of Engineering. Admission requires a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.74 are considered on an individual basis.

Candidates for the Doctor of Philosophy are required to take, in addition to the thesis, at least one-half unit from each of the following areas in the department: (1) applied mathematics, (2) dynamics and vibrations, (3) fluid mechanics, (4) mechanics of solids, (5) properties of materials. A student majoring in one of these five areas in mechanics may also select another of these areas as a second minor, provided that he also takes a first minor in a field other than mechanics.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science is one unit; for the Doctor of Philosophy, the requirement for a sole minor is four units and for a second minor, two units.

In both Master of Science and Doctor of Philosophy programs, emphasis is placed on both course work and research, the latter being either analytical or experimental. Candidates for the master's degree, as well as for the doctorate, must submit a thesis. The department, as part of the Engineering Experiment Station, conducts many research investigations and makes studies of importance to engineering, manufacturing, and other industrial interests as well as to various governmental agencies. Some of the areas of greatest research activity are properties of materials and the elastic and inelastic behavior of load-resisting members; fracture of metals, including stress corrosion cracking, fracture under sustained loading, low temperature embrittlement, cleavage, stress rupture in creep, etc.; properties and behavior of plain concrete, reinforced concrete beams, columns, footings, slabs, and frames; creep of metals and of plastics and other inelastic behavior of materials; hydraulics and fluid mechanics including the nature of turbulence, boundary layer theory, etc.; stresses in railway car wheels, rails and bolted and welded rail joints; mechanical vibrations of machines and structures and vibration damping; photoelastic, electric strain gage, and other methods of experimental stress analysis; materials subjected to static and dynamic loads; theoretical and experimental study of wave motion in continuous media; theoretical and experimental analyses of

problems in fluid flow, dynamics, theory of elasticity, and theory of plasticity. Controlled environment facilities are available for investigations of plastics, plain and reinforced concrete, and wood.

Major in Applied Mathematics. Graduate students in Theoretical and Applied Mechanics also may major in applied mathematics. The student will take at least one-half of his work in one or more of the following areas: dynamics, fluid mechanics, material science, or mechanics of deformable bodies.

In order to obtain a Master of Science degree in Theoretical and Applied Mechanics, with a major in applied mathematics, a student: (1) may waive the thesis and take nine units instead of eight; (2) must take a minimum of two units, but not more than one-half of his total units, in applied mathematics courses.

In order to obtain the Doctor of Philosophy degree in Theoretical and Applied Mechanics with a major in applied mathematics a student, in addition to meeting requirements of the department and the Graduate College, (1) must complete a minor in mathematics with a minimum of four units, but not more than one-half of his total units, from a selected list of courses in the Department of Mathematics; (2) may substitute a course from another department for one of the five area requirements of the Department of Theoretical and Applied Mechanics; (3) may select a member of the Department of Mathematics as his adviser.

GRADUATE FACULTY

Professors: T. J. Dolan (Head of Department), A. P. Boresi, C. E. Bowman, M. E. Clark, W. L. Collins, H. T. Corten, P. G. Jones, C. E. Kesler, H. L. Langhaar, W. M. Lansford, J. Morrow, J. M. Robertson, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, M. C. Stippes, C. E. Taylor, H. R. Wetenkamp, W. J. Worley.

Associate Professors: A. C. Bianchini, G. A. Costello, R. E. Miller, E. M. Shoemaker.

Assistant Professors: F. Bauling, R. S. Jensen, J. W. Murdock, M. Stern, C. W. Tseng.

COURSES FOR GRADUATES

400. **Seminar in Engineering Mechanics.** There are many special topics in the field of mechanics such as fracture of metals, creep of materials, etc., in mechanics of solids; fluid flow problems such as the nature of turbulence, boundary layer theory, nature and effects of roughness of boundary, effects of free surface; dynamics problems such as vibration of beams with moving loads, the gyroscope, etc. Such special topics as these are covered in this course. Each semester one or more of these topics is selected and announced as the area to be covered in this course during that semester. ¼ unit. Staff.

412. **Vibration Analysis.** Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; nonlinear systems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311 or equivalent. Jones.

416. **Energy Principles in Engineering Mechanics.** Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy, Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the

course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR, TAYLOR.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue, and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. ½ or 1 unit. CORTEN.

425. **Mechanics of Inelastic Bodies.** The course presents methods of obtaining relations between loads, deformations, stresses, and strains in various members that are stressed beyond the elastic range. Most applications consider both time-independent and time-dependent (creep) inelastic deformations. Some specific topics are straight and curved beams, columns and beam-columns, fully plastic analysis of statically indeterminate members and structures, torsion of circular and noncircular bars, and torsion-tension of bars of circular cross-section. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321. SIDEBOTTOM, SMITH.

426. **Stress and Deformation in Engineering Components.** Continuation of Theoretical and Applied Mechanics 321: energy principles, forces and moments in plane and three-dimensional indeterminate members; beams on elastic support; flat plates, thick-walled cylinders, rotating disks, including temperature stresses; contact stresses and deflections; values and significance of stress concentrations. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321 or equivalent. SIDEBOTTOM, SMITH.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial, are emphasized. The studies involve critical reviews of experimental and analytical investigations. ½ to 1 unit. Prerequisite: Bachelor of Science in engineering. KESLER.

428. **Analysis of Nonlinear Systems.** Same as Electrical Engineering 428. Singular points and stability considerations are treated. Graphical and analytical methods including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations are considered. 1 unit. Prerequisite: Mathematics 341 and consent of instructor. WORLEY.

431. **Theory of Ideal Fluid Flow.** Together with the following course, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motions are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. 1 unit. Prerequisite: An elementary course in fluid flow and a course in advanced calculus. CLARK, ROBERTSON.

432. **Theory of Flow of Viscous Fluids.** Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially.

Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. 1 unit. Prerequisite: An elementary course in fluid flow and a course in differential equations. CLARK, ROBERTSON.

438. **Turbulence.** Starting with the statistical modes of characterizing turbulence, discussion covers statistical theory, energy considerations, and nature of turbulence in typical flows. Laboratory experiments are used to illustrate hot wire technique of turbulence measurements and the structure of turbulence. 1 unit. Prerequisite: Theoretical and Applied Mechanics 432 or equivalent. ROBERTSON.

441. **Applied Analysis in Engineering.** A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER, SHOEMAKER.

442. **Applied Analysis in Engineering.** Continuation of Theoretical and Applied Mechanics 441. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. LANGHAAR, MILLER, SHOEMAKER.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; Mathematics 341 or equivalent. BORESI, LANGHAAR, MILLER, SHOEMAKER, TAYLOR.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR, STIPPES.

454. **Theory of Shells.** A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR.

457. **Classical Elastostatics.** A modern unified treatment of the concepts and techniques developed in the course of investigation of the Cauchy-Navier equations. Emphasis on the interpretation and motivation of ideas and their interrelation for the solution of three-dimensional problems. Topics include the classical boundary-value problems, existence and uniqueness theorems, stress functions and displacement potentials, singular states of stress, extension of Green's method to the equations of elasticity, method of series, and approximation techniques. Course represents a preparation for (1) students interested in the current state of knowledge in classical elasticity, and (2) students intending to do doctoral dissertations in classical elasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent; consent of instructor. STIPPES.

458. **Wave Motion in Continuous Media.** An analysis of the dynamics of deformable bodies with a major emphasis on elastic media. Introduces the terminology associated with and the methods for treating such problems. Includes a general discussion of the motion of strings, bars, shafts, plates, and other bodies when subjected to load. Detailed examination of approximations involved is made and their engineering significance is discussed. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311, 314, 451; Mathematics 341, 342, 343, or equivalent. STIPPES.

460. **Continuum Mechanics.** Foundations of the general (nonlinear) theories of continuum mechanics. A brief introduction to the tensor calculus is followed by a thorough discussion of the theory of deformation and motion of continua. The stress principle of Cauchy and the basic principles of classical mechanics, i.e., balance of momentum, moment of momentum, and energy, are discussed. A general treatment of constitutive relations is followed by detailed examination of some examples for two particular materials, the elastic solid and the stokesian of some examples for two particular materials, the elastic solid and the stokesian fluid. 1 unit. Prerequisite: Theoretical and Applied Mechanics 351 or equivalent. CARLSON, STERN.

462. **Theory of Plasticity.** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading function. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. SHOEMAKER.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 416 and 451. COSTELLO, LANGHAAR.

467. **Thermomechanics of Nuclear Reactor Systems.** Same as Nuclear Engineering 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal-shock and thermal stress-wave propagation; current thermo-mechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor. BORESI.

472. **Advanced Photoelasticity.** Theoretical and practical aspects of modern photoelasticity. Topics include: three-dimensional photoelasticity, birefringent coatings, dynamic photoelasticity, photoplasticity, photoviscoelasticity, and photothermoelasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 326 and 451 or consent of instructor. TAYLOR.

493. **Advanced Independent Study (Special Problems).** Individual investigation of studies, either analytical or experimental, in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive study of motion having single degree of freedom; critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 154, or 156 or 211 or 212 and 221.

314. **Advanced Dynamics for Engineers.** Three-dimensional kinematics of a rigid body, general dynamics of a rigid body, moments and products of inertia, kinetic energy, rotation of a rigid body about a fixed axis and about a fixed point, Euler equations of motion, gyroscopic theory; introduction to Lagrange equations; engineering applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 211 or equivalent; Mathematics 341 or 345.

315. **Advanced Dynamics with Applications to Engineering Problems.** General advanced methods of dynamics are discussed. Some emphasis is placed on the behavior of special components of guidance and control systems. Associated engineering problems are treated. Topics: Lagrange equations and Hamiltonian canonical equations. Hamiltonian methods; theory of vibrations; special theory of relativity, gyroscopic compass; gyroscopic stabilizer; modern gyroscopes: astronomical applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 314 or equivalent.

321. **Advanced Mechanics of Deformable Bodies.** Basic concepts of mechanics of deformable bodies and brief review of elementary topics; theory of stress and strain at a point; theories of failure, including failure by fracture; unsymmetrical bending; curved beams; torsion of noncircular sections; energy principles, Castigliano's theorem. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or 224.

326. **Experimental Stress Analysis.** Measurement of stresses or deformations that are of significance in the engineering design of load-resisting members; use of optical, electrical, and mechanical instrumentation, models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 212, 221, and 223 or 224. Theoretical and Applied Mechanics 321 is desirable.

334. **Fluid Mechanics and Advanced Hydraulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

335. **Dynamics of Fluids.** An intermediate course in the mechanics of fluids, introducing analytical methods of solution for ideal and real fluids. Potential flow theory, theoretical approaches to viscous flows including boundary-layer theory, and the analysis of compressible flows are indicated. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

346. **Dimensional Analysis and Theory of Models.** The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary-layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. ½ or 1 unit.

351. **Advanced Mechanics of Continuous Media.** General theory of stress; general theory of strain, stress-strain relationships; plane theory of elasticity; advanced topics in bending and torsion. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; a course in differential equations.

392. Analysis and Synthesis of Problems. This course emphasizes the analysis of practical problems in engineering. ½ or 1 unit. Prerequisite: Senior standing in engineering mechanics.

URBAN PLANNING AND LANDSCAPE ARCHITECTURE

The Department of Urban Planning and Landscape Architecture offers work leading to the master's degree. Students applying for admission must have a grade-point average of at least 3.75.

Master of Urban Planning. College graduates in liberal arts and sciences as well as architecture, urban planning, civil engineering, and landscape architecture can prepare themselves for careers in city, state, and regional planning.

The graduate program typically requires two years in residence, but a student with an undergraduate degree in urban planning may complete the program in a shorter period.

To qualify for this degree, a student must take (1) the seminar and thesis courses for at least two units, (2) a total of at least six units of urban planning, and (3) at least two additional units to be chosen from the following fields: architecture, civil engineering, economics, geography, landscape architecture, political science, or sociology.

Master of Landscape Architecture. The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture, architecture, forestry, or other related fields of study. Those students whose undergraduate major is not substantially equivalent to the degree in landscape architecture conferred by the University of Illinois must expect to complete prerequisite courses before taking advanced work in landscape architecture.

To qualify for this degree, a student must complete (1) at least six units of graduate credit in required courses in landscape architecture, (2) at least two additional units to be chosen from the following fields: architecture, botany, urban planning, civil engineering, forestry, geography, geology, horticulture, or recreation. Required credit for the thesis will be specified by the department.

GRADUATE FACULTY

Professors: L. B. Wetmore (Head of Department), W. G. Carnes, W. I. Goodman, J. M. Heikoff, W. M. Keith.

Associate Professors: A. Z. Guttenberg, R. Katz, J. L. Kaufman (Visiting), S. Keyes.

Assistant Professors: T. C. Hazlett, J. R. Voss.

Instructors: A. J. Rutledge, D. L. Walker, Jr.

Urban Planning

COURSES FOR GRADUATES

437. Advanced Urban Planning Studio. Analysis and synthesis problems related to design and development programming for cities, metropolitan areas, and urban regions. 1 to 2 units. Prerequisite: Urban Planning 337, 338, and 374, or consent of instructor.

487. Seminar. ½ unit. Prerequisite: Urban Planning 374.

488. Urban Planning Research. Individual and group instruction in the application of professional competences in urban planning to the analysis of urban development problems and to the formulation of approaches to solution of such

problems. ½ to 2 units. Prerequisite: Urban Planning 171 or consent of instructor.

499. **Thesis Research.** ½ to 2 units. Prerequisite: Graduate standing in urban planning. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Urban Planning Studio, II.** The theory and development of the planning process as it applies to the study of an existing community, including visual surveys, data collection and analysis, "momentum projections," plan making, and implementation programs. 1 to 1½ units. Prerequisite: Urban Planning 236 or consent of instructor.

338. **Urban Planning Studio, III.** Contemporary theories of urban design and structure; planning and design of new communities; circulation and public facilities systems; studies of alternative patterns of growth. 1 to 1½ units. Prerequisite: Urban Planning 337 or consent of instructor.

351. **History of Urban Planning.** Description and analysis of the development of urbanization and the planning of communities from ancient times to the present, as related to environmental and cultural influences. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

374. **Urban Planning Theory.** An examination of the urban planning function within a theoretical, methodological, institutional, and professional context. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

376. **Planning Analysis.** Research and analytic techniques in urban planning; economic base and employment, population, market analysis; derivation and use of statistical data. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

377. **Comprehensive Planning Procedure.** Design and plan-making techniques in urban planning; land use, circulation and community facilities; the development of the comprehensive general plan. ½ unit. Prerequisite: Urban Planning 171.

378. **Planning Legislation and Administration.** Legal tools of planning, zoning, subdivision regulations; housing codes; methodology and application; administrative procedures; the place of planning in the structure of governments; the capital improvement program. ½ unit. Prerequisite: Political Science 150, 151, or 305, 306, or consent of instructor.

380. **Survey of Regional Planning.** Concepts and procedures for planning of regions: river valley, metropolitan, state, and national planning. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

Landscape Architecture

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semipublic, and public properties. 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

447. **Advanced Landscape Construction.** Advanced investigations and applications of new techniques of construction to landscape development. ½ or 1 unit. Prerequisite: Landscape Architecture 243, 244, bachelor's degree in landscape architecture, or consent of instructor. HAZLETT.

457. **Advanced Planting Design.** Theory and application of planting design in relation to private, semipublic, and public properties. ½ or 1 unit. Prerequisite: Bachelor's degree in landscape architecture.

477. Theory and Application of Landscape Design. Advanced studies in the physical and ecological bases of landscape, aesthetic principles, and landscape planning. ½ or 1 unit. Prerequisite: Landscape Architecture 337 or consent of instructor.

487. Seminar. ½ or 1 unit.

499. Thesis Research. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. Advanced Landscape Design, I. Advanced problems of landscape design for urban and institutional situations. 1 to 1½ units. Prerequisite: Landscape Architecture 236.

338. Advanced Landscape Design, II. Terminal project; comprehensive landscape architectural development. 1 to 2 units. Prerequisite: Landscape Architecture 337.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine from a college or university approved by the University of Illinois. If they do not have a veterinary medical degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Areas of specialized study in veterinary medical science include anatomy, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy in Veterinary Medical Science should include in their undergraduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences.

Students planning to work toward the Doctor of Philosophy who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Departmental requirements for the Master of Science or Doctor of Philosophy in Veterinary Medical Science are described in a pamphlet which may be obtained from the office of the head of the department.

GRADUATE FACULTY

Professors: C. A. BRANDLY (Dean of College of Veterinary Medicine), J. O. ALBERTS, P. D. BEAMER, L. E. BOLEY, H. W. HANNAH, L. E. HANSON, H. J. HARDENBROOK, R. D. HATCH, R. H. KOKERNOT, N. D. LEVINE, R. P. LINK, M. RISTIC, L. E. ST. CLAIR, A. G. SCHILLER, D. SEGRE, P. H. SILVERMAN, J. SIMON, A. M. WATRACH.

Associate Professors: D. H. FERRIS, W. G. HUBER, W. C. MARQUARDT, G. T. WOODS.

Assistant Professors: F. L. ANDERSEN, H. W. COX, W. L. MYERS, H. E. RHOADES, A. H. SAFANIE, A. R. TWARDOCK.

Instructor: DIANE K. NORMANDIN.

COURSES FOR GRADUATES

408. **Principles of Hematology.** The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. ½ unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. St. Clair.

415. **Mechanisms of Microbial Infections.** Concepts of host-microorganism relations with emphasis given to the dynamics of microorganisms and pathogenesis of specific infections. 1 unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 332, or equivalent. Hanson, Ristic.

416. **Epizootiology.** Principles and problems of epizootiology with special consideration of the zoonoses; ecology of the host and parasite as related to resistance, adaptation, perpetuation, and distribution; the principles and factors in interference, carrier and latent states, reservoirs and control. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331, Veterinary Medical Science 332, or equivalent, or consent of instructor. Brandly, Kokernot, Levine.

417. **Medical Mycology.** Study of the fungi that cause infections in man and animals; taxonomy, methodology, epidemiology, pathology, and diagnosis. 1 unit. Prerequisite: Microbiology 326, Veterinary Medical Science 332, or equivalent. Rhoades, Watrach.

418. **Concepts and Topics in Immunology.** Newer concepts and theories in the field of immunology, including theories of antibody formation, transplantation immunity, hypersensitivity, and disturbances of the antibody-forming mechanism. Lectures and discussion. ½ unit. Prerequisite: Microbiology 327 or equivalent; consent of instructor. Segre.

430. **Advanced Veterinary Parasitology.** Diagnosis, cultivation, chemotherapy, and host-parasite relations of parasites of animals. ½ or 1 unit. Prerequisite: Veterinary Medical Science 333 and 336 or Zoology 318 and 321, or equivalent; Chemistry 133 or equivalent. Chemistry 350 or equivalent is recommended. Levine, Marquardt.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Dairy Science, and Horticulture 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Dairy Science, and Horticulture 441. A continuation of Veterinary Medical Science 440, moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Veterinary Medical Science 440 or equivalent.

445. **Advanced Macroscopic Pathology.** Concepts and interpretations of gross pathologic changes and the integration of host-parasite reactions. ½ or 1 unit. Prerequisite: Veterinary Medical Science 334 and 335, or equivalent; consent of instructor. Alberts, Beamer.

450. **Advanced Veterinary Pathology.** Advanced study of gross and microscopic pathology of diseases of domestic animals. 1 unit. Prerequisite: Veterinary Medical Science 335 or equivalent. Beamer.

455. **Comparative Oncology.** A comparative study of the nature of mammalian and avian neoplasms based on general and special methods of tumor identification, classification, and experimentation. Lectures, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 445 and 459, or equivalent. Required course for students majoring in pathology in Department of Veterinary Medical Science. Simon.

459. **Advanced Correlative Pathology.** Discussion and interpretation of disease processes of domestic animals. Emphasis on the correlation of gross, micro-

scopic and clinico-pathologic findings with alterations of function. ½ or 1 unit. Prerequisite: Veterinary Medical Science 308, 335, 445, 450, or equivalent; consent of instructor. BEAMER, SIMON, WATRACH.

460. **Advanced Veterinary Physiology.** Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Problems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. 1 unit. Prerequisite: Veterinary Medical Science 315, 316, or equivalent; consent of instructor. T. L. HUBER.

461. **Advanced Veterinary Pharmacology.** Evaluation of drugs, pharmacological aspects of biological antagonisms, chemotherapy, antibiotics, chelating agents and chemical biological correlation. ¾ unit. Prerequisite: Consent of instructor. LINK.

490. **Seminar.** Required of all graduate students whose major is veterinary medical science. ¼ unit. STAFF.

491. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. ½ unit. LEVINE.

492. **Special Problems.** Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Gross Anatomy.** Systematic and topographic study and dissection of the dog. Lectures, discussion, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. ST. CLAIR.

301. **Microscopic Anatomy.** Structure of cells, tissues, membranes, vessels, lymphoid organs, and the hollow viscera, with special reference to the domestic animal. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. SAFANIE.

302. **Gross Anatomy.** Comparative study and dissection of the domestic animals with special reference to development and adaptation to function. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 300 or consent of instructor. ST. CLAIR.

303. **Microscopic and Developmental Anatomy.** Structure and development of organs and systems with comparison in different domestic animals. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 301 or consent of instructor. SAFANIE.

308. **Histochemistry.** Methods used in histochemical and histological analysis in animals. Lectures, discussions, demonstrations, and laboratory. ½ or 1 unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. NORMANDIN.

315. **Physiology.** Physiochemical phenomenon, blood and lymph, circulation, respiration, digestion, absorption, and excretion in domestic animals and birds. Lectures, recitations, demonstrations, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. LINK.

316. **Physiology.** Body fluids and their regulation; urine secretion; acid-base balance; physiology of renal disease in animals; metabolism; heat regulation; liver and biliary system; muscular and peripheral nervous system. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. LINK.

317. **Physiology.** Central nervous system and special senses including vision, taste, smell, and hearing; endocrine organs and their secretion; reproduction and growth. Lectures, demonstrations, and laboratory. ¾ unit. Prerequisite: Veterinary Medical Science 316 or consent of instructor. LINK.

318. **Pharmacology.** General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures, discussions, demonstrations, and laboratory. 1 unit. Prerequisite: Credit or registration in Veterinary Medical Science 315 and 316; consent of instructor. W. G. HUBER.

320. **Pharmacology and Toxicology.** Principles of drug action and an analysis of action of chemical agents on living organisms including intoxications of domestic animals. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Veterinary Medical Science 318 or consent of instructor. W. G. HUBER.

325. **Radioisotopes in Biological Research: Principles and Practice.** Lectures, demonstrations, and laboratory on the fundamentals of radioisotope procedures and applications in biology and medicine. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

332. **Veterinary Microbiology and Immunology.** Lectures, discussions, and laboratories dealing with mechanisms of infection and resistance and the properties, pathogenesis, and control of viral infection of domestic and wild animals. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331 or equivalent; consent of instructor. HANSON, MYERS.

333. **Protozoan and Arthropod Parasites.** Protozoan and arthropod parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty hours; consent of instructor. LEVINE, MARQUARDT.

334. **General Pathology.** The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasia. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses totaling twenty-five hours in histology, parasitology, physiology, and microbiology; consent of instructor. WATRACH.

335. **Special Pathology.** Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 334 or equivalent; consent of instructor. BEAMER.

336. **Helminth Parasites.** Helminth parasites affecting domestic animals and man. Lectures, discussion, and laboratory. ¾ unit. Prerequisite: Courses totaling twenty hours in chemistry or animal biology or both; consent of instructor. LEVINE, MARQUARDT.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology and one year of anthropology, geography, geology, or sociology. KENDEIGH, LEVINE, SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Sociology 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. KENDEIGH, LEVINE, SHIMKIN, STAFF.

392. Special Problems. Individual research on a special problem chosen in consultation with the instructor and department head. ½ unit. May be repeated for a total of one unit. Prerequisite: Registration in veterinary medical curriculum with grade-point average of 3.5 or above. STAFF.

ZOOLOGY

See descriptions and course listings under Life Sciences, page 232.

UNIVERSITY OF ILLINOIS

Where to Write

ADMISSION
Office of Admissions and Records
100a Administration Building, Urbana 61803
or
The Graduate College
330 Administration Building, Urbana 61803

EMPLOYMENT (Hourly)
Director, Student Employment
1 Student Services Building, Champaign 61822

EXTRAMURAL CLASSES
Division of University Extension
101 Illini Hall, Champaign 61822

FELLOWSHIPS, ASSISTANTSHIPS, OTHER FINANCIAL AID
The Graduate College
330 Administration Building, Urbana 61803
or the prospective major department

FOREIGN STUDENTS (Passport, Visa Assistance)
Director, Office of Foreign Student Affairs
314 Student Services Building, Champaign 61822

HOUSING
Director, Housing Division
420 Student Services Building, Champaign 61822

MEDICAL CENTER (Medical and Dental Sciences, Pharmacy)
Dr. Milan V. Novak, Associate Dean of the Graduate College
P.O. Box 6998, Chicago 60680

MOTOR VEHICLE AND BICYCLE REGISTRATION
Motor Vehicle Division
101 North Mathews Avenue, Urbana 61803

PUBLICATIONS
Graduate College Catalog; Time Table; Calendar;
Financial Aid for Graduate Students;
Saturday, Late Afternoon, and Evening Classes for Teachers
The Graduate College
330 Administration Building, Urbana 61803

DEPARTMENTAL BROCHURES
The prospective major department

SERVICES FOR PERMANENTLY PHYSICALLY HANDICAPPED STUDENTS
Division of Rehabilitation–Education Services
Euclid and Gregory Drive, Champaign 61822

VETERANS
Veterans Educational Benefits
100a Administration Building, Urbana 61803

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ERSITY OF ILLINOIS GRADUATE COLLEGE

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NIVERSITY OF ILLINOIS GRADUATE COLLEGE

RBANA DEPARTMENTS / 1966-1967 / UNIVERSITY OF ILLINOIS BULLETIN

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1965-1966

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Veterinary Medical Science	Carl A. Brandly
Zoology	Paul H. Silverman

*Awards master's degree only.
†Awards master's degree in management only.

CALENDAR OF THE GRADUATE COLLEGE

Summer Session, 1966

June 20, Monday	Registration of graduate students not enrolled in the second semester, 1965-1966. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 15.)
June 21, Tuesday	Instruction begins.
June 21, Tues.—22, Wed.	Registration of graduate students enrolled in the second semester, 1965-1966. (Authorization cards distributed on alphabetical basis.)
July 1, Friday	Applications to take French examination on July 15 will not be accepted in Graduate College Office after this date.
July 4, Monday	Independence Day (holiday).
July 8, Friday	Applications to take German examination on July 22 will not be accepted in Graduate College Office after this date.
July 15, Friday	Applications to take Russian examination on July 29 will not be accepted in Graduate College Office after this date.
July 15, Friday evening	French examination.
July 22, Friday evening	German examination.
July 25, Monday	Last day for dropping a course without grade of E.
July 29, Friday evening	Russian examination.
August 12, Friday	No names will be added to the August graduation list after this date.
Aug. 12, Fri.—Aug. 13, Sat.	Summer session examinations.
August 15, Monday	Last day for candidates for the master's degree in August to deposit theses.
September 9, Friday	Last day for candidates for the doctoral degree in October to submit theses and abstracts to Graduate College Office for approval of format.
September 23, Friday	Last day to file application for the master's degree in October.
September 23, Friday	Last day for candidates for the master's degree in October to deposit theses.
September 24, Saturday	Last day for finals for the doctoral degree in October.

September 30, Friday..... Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1966

August 3, Wednesday..... Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1966.

August 31, Wednesday..... Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1966.

First Semester, 1966-1967

August 3, Wednesday..... Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1966.

August 31, Wednesday..... Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1966.

Sept. 15, Thurs.–Sept. 17, Sat. to noon..... Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, September 17. There will be no registration on Saturday, September 24.)

September 17, Saturday..... Last day for registration without payment of late registration fine.

September 19, Monday..... Instruction begins.

September 30, Friday — Applications to take French examination on October 14 will not be accepted in Graduate College Office after this date.

October 7, Friday — Applications to take German examination on October 21 will not be accepted in Graduate College Office after this date.

October 14, Friday — Application to take Russian examination on October 28 will not be accepted in Graduate College Office after this date.

October 14, Friday evening — French examination.

October 21, Friday evening — German examination.

October 28, Friday evening — Russian examination.

October 30, Monday — Last day for adding a course to program.

November 11, Friday — Applications to take French examination on December 2 will not be accepted in Graduate College Office after this date.

November 18, Friday — Applications to take German examination on December 9 will not be accepted in Graduate College Office after this date.

November 19, Saturday — Last day for preliminary examination for the Ph.D. degree if theses credit earned during the semester is to apply to the third stage of program.

November 23, Wednesday, 1 P.M. — Thanksgiving vacation begins.

November 28, Monday, 1 P.M. — Thanksgiving vacation ends.

December 2, Friday — Applications to take Russian examination on December 16 will not be accepted in Graduate College Office after this date.

December 2, Friday evening — French examination.

December 9, Friday evening — German examination.

December 12, Monday — Last day for dropping a course without grade of E.

December 16, Friday evening — Russian examination.

December 22, Thursday, 1 P.M. — Christmas vacation begins.

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January 3, Tuesday, 1 P.M. — Christmas vacation ends.

January 6, Friday — Last day for candidates for the doctoral degree in February to submit theses and abstracts to Graduate College Office for approval of format.

January 13, Friday — No names will be added to the February graduation list after this date.

Jan. 16, Mon.–Jan. 24, Tues. — Semester examinations.

January 23, Monday	Last day for candidates for the master's degree in February to deposit theses.
January 23, Monday	Last day for finals for the doctoral degree in February.
January 30, Monday	Last day for candidates for the doctoral degree in February to deposit theses and abstracts.

Second Semester, 1966-1967

Feb. 2, Thurs.–Feb. 4, Sat. to noon	Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, February 4. There will be no registration on Saturday, February 11.)
February 4, Saturday	Last day for registration without payment or late registration fine.
February 6, Monday	Instruction begins.
February 13, Monday	Last day for application for fellowships for 1967-1968.
February 17, Friday	Applications to take French examination on March 3 will not be accepted in Graduate College Office after this date.
February 24, Friday	Applications to take German examination on March 10 will not be accepted in Graduate College Office after this date.
March 3, Friday	Applications to take Russian examination on March 17 will not be accepted in Graduate College Office after this date.
March 3, Friday evening	French examination.
March 10, Friday evening	German examination.
March 17, Friday evening	Russian examination.
March 20, Monday	Last day for adding a course to program.
March 25, Saturday	Last day for preliminary examination for the Ph.D. degree if theses credit earned during the semester is to apply to the third stage of program.
March 25, Saturday, noon	Spring vacation begins.
April 3, Monday, 1 P.M.	Spring vacation ends.
April 7, Friday	Applications to take French examination on April 28 will not be accepted in Graduate College Office after this date.
April 24, Monday	Applications to take German examination on May 5 will not be accepted in Graduate College Office after this date.

April 24, Monday	Last day for dropping a course without grade of E.
April 28, Friday	Applications to take Russian examination on May 12 will not be accepted in Graduate College Office after this date.
April 28, Friday	No names will be added to the June graduation list after this date.
April 28, Friday	Honors Day. Classes dismissed at noon.
April 28, Friday evening	French examination.
May 5, Friday evening	German examination.
May 12, Friday evening	Russian examination.
May 15, Monday	Last day for candidates for the doctoral degree in June to submit theses and abstracts to Graduate College Office for approval of format.
May 26, Friday	Last day for candidates for the master's degree in June to deposit theses.
May 29, Monday	Last day for finals for the doctoral degree in June.
May 30, Tuesday	Memorial Day (holiday).
May 31, Wed.–June 8, Thurs.	Semester examinations.
June 5, Monday	Last day for candidates for the doctoral degree in June to deposit theses and abstracts.
June 17, Saturday	Commencement exercises.

Summer Session, 1967

June 19, Monday	Registration of graduate students not enrolled in the second semester, 1966-1967. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 14.)
June 20, Tuesday	Instruction begins.
June 20, Tues.–June 21, Wed.	Registration of graduate students enrolled in the second semester, 1966-1967. (Authorization cards distributed on alphabetical basis.)
June 30, Friday	Applications to take French examination on July 14 will not be accepted in Graduate College Office after this date.
July 4, Tuesday	Independence Day (holiday).
July 7, Friday	Applications to take German examination on July 21 will not be accepted in Graduate College Office after this date.

July 14, Friday	Applications to take Russian examination on July 28 will not be accepted in Graduate College Office after this date.
July 14, Friday evening	French examination.
July 21, Friday evening	German examination.
July 24, Monday	Last day for dropping a course without grade of E.
July 28, Friday evening	Russian examination.
August 10, Thursday	No names will be added to the August graduation list after this date.
Aug. 11, Fri.–Aug. 12, Sat.	Summer session examinations.
August 14, Monday	Last day for candidates for the master's degree in August to deposit theses.
September 8, Friday	Last day for candidates for the doctoral degree in October to submit theses and abstracts to Graduate College Office for approval of format.
September 22, Friday	Last day to file application for the master's degree in October.
September 22, Friday	Last day for candidates for the master's degree in October to deposit theses.
September 23, Saturday	Last day for finals for the doctoral degree in October.
September 29, Friday	Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1967

August 2, Wednesday	Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1967.
August 30, Wednesday	Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1967.

The Graduate College

A land-grant institution, the University of Illinois has its main campus at Urbana-Champaign, a community of 94,500 located 128 miles south of Chicago. Total enrollment in the various branches of the University—the Graduate College and undergraduate colleges at Urbana, the graduate and professional colleges at the Medical Center, Chicago, and the undergraduate colleges at Chicago Circle—exceeded 44,000 in 1965-1966. The combined faculty and staff included the full-time equivalent of more than 14,700 members.

The Graduate College of the University of Illinois at Urbana offers instruction leading to advanced degrees in over one hundred fields of learning. Graduate enrollment currently exceeds 8,000 students who represent every state and seventy foreign countries. Today, a graduate faculty of 1,500 implements the University of Illinois Statutes which charge the Graduate College with the responsibility "to safeguard and promote standards of graduate work on the Urbana-Champaign campus and at the Medical Center, Chicago, and to promote and assist in the development of research in all fields."

Graduate work in the medical and dental sciences and in pharmacy is offered in Chicago at the University's Medical Center. Inquiries concerning these programs should be directed to Dr. Milan V. Novak, Associate Dean of the Graduate College, University of Illinois at the Medical Center, 1853 West Polk Street, Chicago (P.O. Box 6998, Chicago 60680). It is also expected that by the fall of 1967 graduate programs in a limited number of disciplinary areas will be available at the University's Chicago Circle. Information may be obtained by writing to Dr. R. Curtis Retherford, Associate Dean of the Graduate College, University of Illinois at Chicago Circle, 2037 University Hall, Chicago (P.O. Box 4348, Chicago 60680).

Graduate instruction offered at the Urbana campus is listed by areas on pages 3 to 5 and is described in detail within the departmental listings, arranged alphabetically in this catalog.

The general requirements for admission and the degree requirements established by the Graduate College are described in this introductory section. All candidates for degrees must meet these requirements as well as those specified by the major departments within the departmental listings.

UNIVERSITY RESOURCES

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 3,888,983 volumes, all but about 294,000 of them located in Urbana. The remainder are held by the Library of Medical Sciences in Chicago and the library at Chicago Circle.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 524,950 pamphlets, 298,830 maps and aerial photographs, and 295,400 music scores and parts. More than 20,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archaeology; sixteenth- and seventeenth-century English literature, especially the Milton-Shakespeare period; eighteenth-twentieth century English literature, American humor and folklore; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

In the social sciences, the Library's holdings are significant for western United States history, Abraham Lincoln and the Civil War, Latin American history of the Revolutionary period, Italian history, medieval and modern European history, German history for 1830-1900, Irish history, international law and relations, political science, law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a general catalog of more than 5,000,000 cards, a union catalog of titles owned by about two dozen major American and foreign libraries; printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained. Following are the principal collections in the main library building: Browsing Room, Classics, Commerce, Education and Social Science, English, History and Philosophy, Human Relations Area Files, Library Science, Map and Geography, Modern Language, Newspaper, Physical Education, Rare Book Room, and Undergraduate Library.

Elsewhere on the campus are departmental libraries for the following fields: Agriculture, Architecture and Fine Arts, Biology, Ceramics, Chemistry, City Planning, Engineering, Geology, Home Economics, Journalism and Communications, Labor and Industrial Relations, Landscape Architecture, Law, Mathematics, Music, Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are the general bookstacks, housing about 2,000,000 volumes, and over 300 carrels in the bookstacks, assigned to individuals engaged in extended study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Digital Computers. See Department of Computer Science, page 117.

Electron Microscope Laboratory. The Electron Microscope Laboratory, located in the basement of Bevier Hall, is a central facility for instruction and research in behalf of all University departments. It is equipped with a Siemens Elmiskop I, an Hitachi HS-6, and RCA models EMU-3C, EMU-2C, EMU-2F, EMT, and EMC electron microscopes. Ancillary equipment includes two ultramicrotomes, a shadowcaster, an RCA electron diffraction unit, and complete darkroom and general facilities.

The instructional program consists of the following courses: Biology, Chemistry, or Zoology 423, Electron Microscopy; Biology, Chemistry, or Zoology 429, Electron Microscopy Laboratory; Zoology, Entomology, Microbiology, or Physiology 430, Biological Ultrastructure; and seminars and special workshops. The facilities are available for research conducted by qualified faculty-staff members and graduate students.

Physical Environment Unit. The facilities of the Physical Environment Unit provide unique opportunities for pursuing interdisciplinary researches on the responses of biological systems to stresses imposed by the physical environment. An altitude chamber accommodating six human beings permits simulation of altitudes up to 45,000 feet. Air temperature and humidity may be controlled in this chamber to permit investigation of the combined stresses of low environmental pressure and heat or cold. Additional controlled environment rooms provide flexible areas where special test facilities may be installed. All departments and divisions of the University needing closely controlled environmental conditions for research or instructional work are encouraged to utilize the special skills and equipment available

in the Unit. Although primarily designed for studies with human subjects and animals, engineering and physical science projects are not excluded, if space is available.

Radiocarbon Laboratory. The Radiocarbon Laboratory is an all-University facility for graduate training and research involving the use of the tracer technique with carbon-14 and/or tritium. It is equipped with liquid scintillation spectrometers, vibrating reed electrometers, gas counters, radio-gas chromatography units, high vacuum systems, combustion set-ups, and auxiliary radiochemical equipment.

A prerequisite for research in the Laboratory is the carbon-14 course, Chemistry-Animal Nutrition 496, which emphasizes experimental techniques employed in the synthesis, degradation, isolation, establishment of purity, and assay of radioactive carbon compounds. Members of the staff present this course one semester each year.

Social and Cultural Facilities

Students at the University of Illinois have a wide choice of activities and facilities available to them. Campus events announced in a weekly calendar include musical programs, lectures, University forums, campus and traveling theatrical productions, weekend movies and dances, and fine arts and scientific exhibitions.

The Krannert Art Museum provides galleries for displaying the University's permanent collection of art works and for presentation of other exhibitions. A University Festival of Contemporary Arts, held every two years, includes special events and exhibits in the areas of art, architecture, landscape architecture, urban planning, drama, motion picture, literature, printing, dance, and music. Illini Union, the campus social center, has lounges, dining facilities, and recreational and meeting rooms available to students and faculty.

ADMISSION

General Requirements

It is recommended that prospective students apply for admission about two months before the beginning of the term in which they expect to enroll. Applications for admission or readmission, including all necessary credentials, *must be submitted* by domestic students at least two weeks prior to registration or by foreign students at least six weeks prior to registration.

A nonrefundable deposit of $30.00 on tuition and fees is required of all *new and readmitted domestic graduate students.* This deposit should not be sent until requested by the University. Graduate stu-

dents assured of the award of a fellowship, assistantship, or tuition and fee waiver are permitted to confirm their intention to enroll without payment of the advance deposit.

Admission forms may be obtained from the Office of Admissions and Records, 100a Administration Building, or from the Graduate College, 330 Administration Building. Foreign students should request admission by letter (see page 22).

An applicant is favorably considered for admission to the Graduate College if (1) he is a graduate of an institution awarding a baccalaureate degree comparable to that granted by the University of Illinois; (2) he is adequately prepared for advanced study as demonstrated by his previous program of study and his scholastic record; and (3) he is recommended for admission by his major department and the Dean of the Graduate College.

The prerequisites for advanced work in the various fields of specialization are listed in the departmental sections of this catalog. Also listed are the scholastic grade-point averages which must be met before an application for admission is considered. The scholastic average is expressed for the last sixty semester hours of work completed in terms of a five-point scale (A=5.0; B=4.0; etc.).

A department's recommendation with respect to the admission of an applicant is not based solely on the scholastic average. Therefore, not all who meet the scholastic requirements can be admitted.

Physical Examination

Each new student proposing to enroll in the University of Illinois at Urbana-Champaign or at the Chicago Circle campus for a full semester is required, before completion of his registration, to present adequate evidence of satisfactory physical and mental health as determined by the Director of Health Services of the University.

Part-time graduate students enrolling for one unit, or five hours, or less, are not required to have a physical examination except in those instances when the Director of Health Services considers the physical examination, in addition to the required tuberculin test, advisable for the protection of the health of other students.

Former and continuing students in the University of Illinois may also be required to present adequate evidence of satisfactory physical and mental health prior to readmission to or continuation in the University. All former students re-entering after an absence of one semester or longer are required to have the tuberculin test as a condition of readmission. All students who have lived abroad for an academic year or its equivalent are required to have a complete physical examination when returning to reregister in the University.

New students enrolling in the summer session are required to take the tuberculin test administered by the Health Service without charge as a part of the registration procedure, but are not required to take the physical examination until such time as they enroll for a full semester. Anyone who has had a normal chest film within the past six months, and presents evidence thereof, is excused from the tuberculin test.

A complete physical examination, including chest X-ray, performed by the University Health Service, is required of all foreign students prior to receipt of a permit to enter the University, including those foreign students whose first enrollment at the University of Illinois is in the summer session. This examination is given by the Health Service without charge.

Detailed explanatory material and medical forms for reporting the pre-entrance examination are forwarded to each student who receives a permit to enter.

Graduate Study by Seniors at the University of Illinois

A senior at the University of Illinois whose academic average for his junior and senior work is 4.0 or above may apply for admission to the Graduate College if he is *within five hours* of his baccalaureate degree. If he is *within ten to six hours* of that degree he may apply to take some work for graduate credit. Forms describing the procedure to be followed are available at the Graduate College Office.

Readmission

A former student who has not registered for one or more semesters must file an application for readmission. This form should be submitted to the Office of Admissions and Records as early as possible and not later than two weeks before the beginning of the term in which he expects to register. A nonrefundable deposit of $30.00 on tuition and fees is required of all students seeking readmission, unless they have been assured of the award of a fellowship, assistantship, or tuition and fee waiver.

Foreign Applicants

A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Office of Admissions and Records, 100a Administration Building, Urbana, Illinois 61801. He should enclose with his initial inquiry for admission, copies of his complete academic records which have been officially certified by the educational institutions he has previously attended. These official

records should include a listing of all final degrees, diplomas, or certificates awarded.

An authenticated English translation must accompany all documents that are in a language other than English.

Prospective applicants must also provide the following information: full legal name; address to which reply should be mailed; place and date of birth; name of the country of which he is now a citizen; marital status; form of permanent physical handicap, if any; the subject in which he wishes to specialize; native language; whether he wishes to be a candidate for an undergraduate or graduate degree; amount in United States dollars available for support, the source of income, and the length of time this support is guaranteed; a complete chronological list of all elementary and secondary schools, and colleges attended, with the exact dates of attendance, and diplomas, certificates, or degrees received; if he is not attending school, his occupation since leaving school; the date he plans to enter.

Because it is not advisable to undertake a graduate program at the University of Illinois without adequate competence in the English language, all applicants whose native tongue is not English are required to take an English proficiency test. Details and instructions regarding the test are sent to the applicant after it has been determined that he is otherwise eligible for admission. At the same time, the applicant also is sent a graduate application form. Upon receipt of satisfactory English test results and the completed application form, the Office of Admissions and Records issues documents admitting the student to the Graduate College, including an appropriate certificate to apply for a visa to enter the United States.

FEES AND EXPENSES

Expenses

Although personal expenses may vary according to the individual needs and benefits, the following estimates indicate the average basic living costs for single students. Cost of daily board ranges from $2.50 to $3.00, single rooms in private student houses from $30.00 to $48.00 a month, and double rooms from $30.00 to $35.00 a month for each person. In some cases, apartments are shared and the monthly costs per person can be from $50.00 to $60.00. Graduate halls operated by the University offer single rooms at rates ranging from $424.00 to $518.00 for the academic year and double rooms at rates ranging from $360.00 to $486.00 per person for the same period. A board contract may be purchased for one semester at a rate of approximately $240.00.

Tuition and Fees

Tuition and other fees, as indicated below, are payable in full when the student registers, unless the installment plan of payment is elected. An additional charge of $2.00 is made for this privilege.

SEMESTER

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 10 hours Above 2½ units		Above 5 to 10 hours Above 1¼ to 2½ units		Above 0 to 5 hours Above 0 to 1¼ units	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 85.00	$375.00	$60.00	$265.00	$35.00	$155.00
Service Fee[1]	40.00	40.00	25.00	25.00	10.00	10.00
Hospital-Medical-Surgical Insurance Fee[2]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$135.00	$425.00	$95.00	$300.00	$55.00	$175.00

EIGHT-WEEK SUMMER SESSION

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 5 hours Above 1¼ units		Above 2½ to 5 hours Above ¾ to 1¼ units		Above 0 to 2½ hours Above 0 to ¾ unit	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 45.00	$190.00	$30.00	$130.00	$20.00	$ 80.00
Service Fee[1]	20.00	20.00	15.00	15.00	5.00	5.00
Hospital-Medical-Surgical Insurance Fee[2,3]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$ 75.00	$220.00	$55.00	$155.00	$35.00	$ 95.00

[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off-campus are exempt fom the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of this fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed waiver and assumption of responsibility is required. Persons registered for thesis research *in absentia* are not assessed this fee.

[3] If insurance coverage for the period between the close of the summer session and the beginning of the first semester is not desired, $5.00 will be refunded if requested in writing prior to the final date established for full refund of fees.

NONCREDIT COURSES

Students who register in noncredit courses pay tuition and fees as follows:

(1) Persons (except those holding exemptions) who register *on campus* for doctoral thesis research (499) only, without credit, are charged the following:

SEMESTER:

Tuition	$10.00
Service Fee	10.00
Hospital-Medical-Surgical Insurance Fee	10.00

EIGHT-WEEK SUMMER SESSION:

Tuition	$10.00
Service Fee	5.00
Hospital-Medical-Surgical Insurance Fee	10.00

(2) Persons who register for doctoral thesis research (499) *in absentia* without credit are charged only a tuition fee of $10.00
(Those registered *in absentia* for credit pay the regular tuition, resident or nonresident, as applicable.)

(3) Persons who register in noncredit seminars, either alone or in addition to other courses ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(4) Persons not holding tuition waivers who register for less than a full program of credit courses (Range II or III) pay for each noncredit course $15.00
(This is in addition to the required tuition and fees for credit courses.) If taken alone noncredit courses other than thesis research and seminar are assigned to Range III.

(5) University employees who register at the request of their department in noncredit courses especially established to improve the work of the employee ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(6) Persons wishing to attend a campus course as a visitor only (special permit required) pay for each course a fee of $15.00

Residence Classification

The residence classification of an applicant is determined on the basis of information given on his application and other credentials. Fees are assessed in accordance with this decision. If the student believes he has a legitimate cause for change of status, he may, by petition, on a form provided by the Office of Admissions and Records, request a change. Petitions are considered *within thirty days* from the date designated in the official University Calendar as that upon which instruction begins for the academic period for which the fee is payable. However, if the nonresident fee was not assessed on or prior to that

date, the claim for refund may be filed *within thirty days* after the nonresident fee was assessed and the student was given notice of its assessment. Tuition and fees will not be adjusted for that academic term if the petition is not filed within these time limits. Additional evidence to substantiate a request may be required. If the student expects to ask for a change of residence classification, it is advisable for him to request the adjustment be made prior to registration.

In the event a student who claims he is a resident student is dissatisfied with an adverse ruling of the Director of Admissions and Records, he may obtain a review of such decision by the Legal Counsel of the University by filing a written request with the Director of Admissions and Records within twenty days after he has been notified of the ruling.

Further information concerning residency may be secured by contacting the Director of Admissions and Records, 100a Administration Building, Urbana, Illinois 61801. A brochure entitled *Regulations Governing Assessment of Resident or Non-resident Student Fees* is also available.

Special Fees

Below is a partial list of special fees pertaining to graduate students. A complete schedule of tuition and fees may be obtained from the Office of Admissions and Records, 100a Administration Building.

Late Registration Fine—$15.00. All students, whether on appointment or not, who complete registration for courses on campus after the close of the regular registration, are subject to this fine in addition to the tuition and fees. A student's registration is not complete until his tuition and fees have been paid in full, or he has made arrangements with the Bursar's Office for deferment of payment. Students who register late in any term pay the same tuition and fees as students who register at the beginning of the term.

Change of Program Fee—$1.00. This fee is charged for every course change slip issued at the request of the student after the completion of registration.

Vehicle Registration. All resident students enrolled in the Graduate College who have a motor vehicle in their possession are required to register this vehicle with the Motor Vehicle Division.

Graduate students holding at least one-half time teaching or research appointments are included under the term "faculty-staff" and have the option of purchasing an "E" permit or securing a "G" permit with reduced privileges at no cost. Fellowship holders are accorded these same privileges.

All other students who possess and maintain a motor vehicle in the Urbana-Champaign community are assessed a fee of $5.00 per year and are issued the appropriate sticker. Student motor vehicle registrations are effective from September 1 to September 1 of each year with all interim registrations (including new, transfer, and returning students) being effective until the following September 1. All motor vehicles in possession of students must be registered within one school day of the acquisition of such vehicles.

The Motor Vehicle Division requires the registration of all motorcycles, motor scooters, and motor bicycles. The fee for such registration is $3.00 per year.

Bicycles also must be registered with this Division. No fee is charged for such registration.

Questions relating to vehicle regulations should be referred to the Motor Vehicle Division, 101 North Mathews Avenue, Urbana, Illinois 61801.

Assessments and Exemptions

Assessments. For fee assessment purposes, a staff appointment must require service for not less than three-fourths of the term. This is interpreted as a minimum of three and one-half months in a semester, nine weeks in a quarter, and six weeks in an eight-week summer session. Staff tuition and fee privileges do not apply to students employed on an hourly basis in either an academic or nonacademic capacity, or to persons on leave without pay.

For fee assessment purposes, a *permanent* nonacademic employee is defined as a person who has completed the six months' probationary period on an original appointment and has been certified under Civil Service to an established nonacademic position, regardless of the percentage of time required in the position.

University employees appointed to established Civil Service positions whose rate of pay is determined by negotiation, prevailing rates, union affiliation, etc., are not considered as paid on a hourly basis and are entitled to the same tuition and fee privileges accorded to other staff members under the regulations.

Any student who resigns his staff appointment, or whose appointment is cancelled before rendering service for at least three-fourths of the term, becomes subject to the full amount of the appropriate tuition and fees for that term unless he withdraws from his University classes at the same time the appointment becomes void. Such students are not assessed tuition and fees for that term if they file clearance for graduation within one week after the appointment becomes void.

Exemptions. A student may be exempted from one or more of the usual charges if he qualifies under the following conditions:

TUITION IS WAIVED FOR:

(1) Holders of tuition waiver scholarships.
(2) All academic employees of the University or of allied agencies on appointment for at least 25 per cent but not more than 67 per cent of full-time services.
(3) All permanent nonacademic employees of the University or allied agencies on appointment for at least 25 per cent of full-time who register in University courses in Range II or III.
(4) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(5) Holders of grants or contracts from outside sponsors which provide payments to cover the total costs of instruction.
(6) Cooperating teachers and administrators who receive assignment of practice teachers. (Exemption is provided in one term for each semester of assignment within the same calendar year—September through August.)
(7) Persons registered in noncredit seminars only.
(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

NONRESIDENT PORTION OF TUITION (IF SUBJECT TO PAYMENT OF TUITION) IS WAIVED FOR:

(1) All staff members (academic, administrative, or permanent nonacademic)—on appointment for at least 25 per cent of full time with the University or the allied agencies.
(2) The faculties of state-supported institutions of higher education in Illinois.
(3) The teaching staff in the private and public elementary and secondary schools in Illinois.
(4) The spouses and dependent children of those listed in items 1 and 2 above. (Dependent children are those who qualify as dependents for federal income tax purposes.)
(5) Persons actively serving in one of the Armed Forces of the United States who are stationed and present in the state of Illinois in connection with that service.
(6) The spouses and dependent children of those listed in item 5 above, as long as they remain stationed, present, and living in this state.

For those listed in items 1 through 4 on page 28, who are eligible for such waiver in the final term of the academic year, except as indicated under summer session below, this privilege is also extended to the summer session immediately following.

SERVICE FEE IS WAIVED FOR:

(1) All staff members of the University or allied agencies on appointment for at least 25 per cent of full time.
(2) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(3) Students registered *in absentia.*
(4) Students registered in courses taught off campus.
(5) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(6) Cooperating teachers and administrators described in item 6 above (under tuition waivers).
(7) Persons registered in noncredit seminars only.
(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

HOSPITAL-MEDICAL-SURGICAL INSURANCE FEE IS WAIVED FOR:

(1) Students presenting evidence of equivalent coverage upon approval of a petition presented to the University Insurance Office not later than the final day established for full refund of fees.
(2) Persons registered for thesis research *in absentia.*
(3) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(4) Students for whom this fee has been assumed by the Graduate College.
(5) Persons registered in noncredit seminars only.
(6) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.

SUMMER SESSION TUITION AND FEES ARE WAIVED FOR:

(1) Students holding academic appointments to the close of the final term of an academic year either as employees or fellows, and for whom tuition and/or fees have been provided through waiver or through cash payment by an outside agency, are entitled to a waiver of the same kinds of tuition and fees for the summer session immediately following, provided they hold no appointments during that summer session.

(2) Students holding summer session appointments as fellows or as employees are subject to such tuition and fees as would be assessed in accordance with the principles expressed above.

Advance Deposit

Each new, readmitted, and advance enrolled continuing student (except foreign students who, at the time of application, are residing outside the United States, and certain others specifically exempted) who wishes to register for a fall semester is required to make an advance deposit in order to secure the place reserved for him. New and readmitted students wishing to enroll in the spring semester are also required to make an advance deposit.

This is not an additional cost for attending the University but is applied to each student's tuition and fees in the semester for which he is approved. In case the student fails to enter the University in that semester, the deposit may not be applied toward any future registration. The deposit should not be sent until requested by the University. It is nonrefundable except in very special cases.

The following graduate students may confirm their intentions to register without payment of the advance deposit:

(1) All new foreign students.
(2) New, readmitted, and advance enrolled continuing graduate students holding a fellowship, academic or nonacademic staff appointment, or graduate tuition and fee waiver.
(3) New, readmitted, and advance enrolled continuing graduate students who receive a financial award from an agency outside the University, and whose complete tuition and service fee are billed to the agency by the Bursar.
(4) Doctoral candidates who have passed the preliminary examination.

Housing

The University has residence facilities in Arthur Hill Daniels Hall and Stuart Pratt Sherman Hall, two separate residence hall complexes for approximately 1,000 single graduate students, both men and women. In one unit, Daniels Hall, contract food service in an undergraduate dining hall located directly across the street can also be arranged. In addition, the University provides a limited number of apartments for married students, with priority in assignment given to part-time research and teaching assistants.

Applications for accommodations in the University graduate residence halls or the University-owned apartments for married students may be obtained from the Housing Division, 420 Student Services

Building, Champaign, Illinois 61820. The Housing Division also maintains a courtesy list of private apartments and rooms available in homes in the community. Office hours are from 8:00 a.m. until 12:00 noon and 1:00 to 5:00 p.m. Monday through Friday, and from 9:00 a.m. until 12:00 noon each Saturday. On the two weekends prior to registration, office hours are maintained from 10:00 a.m. until 12:00 noon and 2:00 to 4:00 p.m. on Saturday and Sunday. University offices are not open on national holidays.

Installment Plan for Payment of University Fees and Housing Charges

Students registered on the Urbana-Champaign campus are given the option of paying tuition, fees, and residence hall charges (in the case of single graduate student housing only) on an installment basis. Tuition and fee charges for each of the first and second semesters are collected in four installments, the first payable at registration and the remaining in each of the following months. The advance deposit, if paid, is applied against the first installment. If this results in overpayment, the remainder is applied against subsequent installments. Summer session charges are payable one-half at registration and one-half during the following month. This plan does not apply to registration in extra-mural and correspondence courses, or to University housing contracts on an annual lease basis, which are payable monthly.

Students electing the installment plan for payment of tuition and fees are assessed a $2.00 service charge. An additional service charge of $2.00 is assessed in the case of the flight instruction fee of $375.00 if paid on the installment basis. There is no service charge for the payment of University housing accounts on the installment basis.

Refund of Fees

A student subject to tuition and/or fees who files clearance papers for withdrawal from the University during any term, for reasons other than military or other approved national defense service, receives a refund as listed below. (Special refund regulations govern withdrawals for active military or other approved national defense service.)

IN A SEMESTER:

(1) During the first ten days of instruction in a semester, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $30.00.[1] When the total assessment has been less than $30.00, the full amount of the assessment, if any, is nonrefundable.

(2) After the first ten days but within the first half of the semester, one-half of the total amount of the tuition and fees assessed which remains after deduction of the nonrefundable charge is refunded.

(3) After the midpoint of the semester, no refund is allowed.

IN AN EIGHT WEEK SUMMER SESSION:

(1) During the first five days of instruction in the summer session, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $15.00.[1] When the total assessment has been less than this amount, the full amount of the assessment, if any, is nonrefundable.
(2) After the first five days but within the first half of the summer session, one-half of the amount assessed which remains after deduction of the above mentioned $15.00 is refunded.
(3) After the midpoint of the summer session, no refund is allowed.

A student who reduces his registration to a lower range receives a refund of the full amount of the difference in tuition and fees specified for such schedules provided the changes are made during the period designated for refund of full fees in case of withdrawal from the University. One-half of the above differences is refunded if the changes are made during the period for one-half refund in case of withdrawal from the University. Thereafter, no rebate is allowed.

[1] The nonrefundable charge includes the hospital-medical-surgical insurance fee, if originally paid; the student who withdraws from the University continues to be covered by the insurance until the close of the term.

FINANCIAL AID

Various types of financial assistance are available each year to promising students in all fields of study in the Graduate College. Detailed information about qualifications and application procedures for these awards is given in the brochure, *Financial Aid for Graduate Students,* which may be obtained by writing to the Graduate College or to any of the graduate departments.

The principal kinds of awards are listed below.

Fellowships

University Fellowships. University Fellowships, which are awarded on the basis of an all-University competition, are generally unrestricted as to the student's field of graduate study and provide stipends of not less than $1,800 for the academic year, or $2,250 for eleven months, with exemption from tuition and all regular fees which are assessed at the time the student registers. A student receiving a University Fellowship may accept, if offered, a part-time teaching assistantship to a maximum of one-quarter time. University Fellows must carry a full program—four units or the equivalent.

A number of fellowships are also provided for teaching assistants for the summer session only. These fellowships are restricted to gradu-

ate students who have held teaching assistantships at the University of Illinois for at least half-time for both semesters of the preceding academic year, who have earned not less than two units of graduate credit during that year, and who have demonstrated superior scholarship. Like regular University Fellows, they are selected on the basis of an all-University competition. The Summer Fellowships carry stipends of $450 for the eight-week summer session, plus tuition and fee exemptions.

In addition to the all-University awards, there are offered a number of Fellowships in the Creative and Performing Arts. These awards are made primarily on the basis of the applicant's creative achievements and promise rather than on his academic and scholarly qualifications. Eligible for these fellowships are students in the fields of dance, theatre, architectural design, landscape architecture, painting and printmaking, graphic design, industrial design, and music. Applicants may contact the appropriate department.

National Defense Graduate Fellowships. The University of Illinois Graduate College has a number of National Defense Graduate Fellowships which are financed under Title IV of the National Defense Education Act of 1958, and administered with the cooperation of participating universities. This program assists students who are preparing to teach in the nation's colleges and universities. Each fellowship, restricted to citizens or permanent residents of the United States, is for a three-year period to a student beginning his graduate studies. The stipend for the academic year is $2,000 for the first year, $2,200 for the second, and $2,400 for the third, plus an allowance for dependents. These fellowships provide exemption from tuition and all regular fees which are assessed at the time the student registers. A holder of a Title IV fellowship may, under certain conditions, also be appointed as a part-time teaching assistant.

Under Title VI (Modern Foreign Languages) of the National Defense Education Act, the University of Illinois participates in programs in Russian and in Latin American Language and Area Studies. These fellowships, restricted to citizens or permanent residents of the United States, are intended for students planning a college or university teaching career or other career centering on problems of the language area. The stipend for the fellowship, which is renewable, is $2,250 for the academic year, or $2,700 for the summer and academic year, plus an allowance for dependents. Title VI fellowships also provide for the payment of tuition and fees.

Requests for information and application materials should be directed to the student's prospective department.

Industrial, Endowed, Special Fellowships, and Traineeships. Various industrial firms, foundations, government agencies, and private indi-

viduals have generously donated funds to support a number of special fellowships for graduate students at the University of Illinois. The stipends and supplemental allowances of these fellowships are not uniform, and most of them are restricted to students in particular areas of study. Brief descriptions of the names, donors, fields, and other conditions pertaining to each are presented in the brochure, *Financial Aid for Graduate Students,* referred to above.

Traineeships

National Science Foundation Traineeships. Under this program, grants are made directly to the participating institutions, who select a specific number of promising individuals for full-time graduate study. Appointments may be made only to citizens of the United States (or native residents of a United States possession) who are enrolled in programs leading to an advanced degree in the mathematical, physical, medical, biological, or engineering sciences, anthropology, economics, geography, the history and philosophy of science, linguistics, political science, psychology, and sociology. Also included are interdisciplinary areas which are comprised of overlapping fields among two or more sciences (for example, geochemistry and meteorology).

The basic stipends for twelve months are $2,400 for those at first-year level, $2,600 for those at intermediate-year level, and $2,800 for those at terminal-year level, plus exemption from tuition, service fee, and hospital-medical-surgical insurance fee. An allowance of $500 is granted for each dependent. Recipients of these awards may elect a nine months' tenure, rather than twelve months, with a corresponding decrease in the stipends and allowances.

Inquiries concerning traineeships should be directed to the appropriate department at the University.

National Aeronautics and Space Administration Traineeships. The National Aeronautics and Space Administration sponsors a number of traineeships at the University of Illinois for students who are majoring in the space-related sciences and technology. Awards are made to first-year graduate students and provide an annual tax-free stipend of $2,400 for twelve months, with exemption from tuition and all regular fees that are assessed at the time of registration. An allowance of up to $1,000 is provided for dependents, and the traineeship may be renewed for a total of three years. NASA trainees must carry a full program—four units or the equivalent—and may not accept an additional appointment of any kind for remuneration. Inquiries concerning this program should be directed to the student's prospective major department.

Assistantships

The various departments of the University employ a number of graduate students as teaching or research assistants. The usual appointment is for half-time service, at a salary of $2,300 for the academic year (September to June). Applications may be made directly to the appropriate department.

Assistants holding appointments ranging from 25 through 67 per cent of full-time service are exempt from the tuition and service fees, but not from the hospital-medical-surgical insurance fee. For more detailed information concerning fee assessment, see pages 27 to 30.

There are also a number of part-time assistantships available in non-teaching bureaus and agencies. For further information and application materials, write directly to: Bureau of Business Management, Bureau of Community Planning, Bureau of Economic and Business Research, Center for Instructional Research and Curriculum Evaluation, Department of Computer Science, Institute of Communications Research, Institute of Government and Public Affairs, Institute for Research on Exceptional Children, Physical Environment Unit, and Small Homes Council-Building Research Council. All agencies may be addressed in care of University of Illinois, Urbana 61801.

Part-time appointments as student residence hall counselors are also available. These provide cash stipends plus room and board and the same exemption from tuition and the service fee accorded other staff members. For further information, students should write to the Dean of Men or the Dean of Women, Student Services Building.

Tuition and Fee Waivers

These awards provide exemption from the tuition and service fee, but not from the hospital-medical-surgical insurance fee, for the academic year and the summer session immediately preceding or following. Students holding these awards must be in residence and must register for at least three units each semester during the academic year. They may, however, accept part-time or incidental employment not to exceed twenty hours a week either within or outside the University.

Veterans who are admissible to a graduate program and who meet certain residence requirements may be eligible for exemption from tuition and certain fees under the state statute concerning Military Scholarships. Further information may be obtained from the Director of the Undergraduate Scholarship Program, 907 South Sixth Street, Champaign, Illinois 61820.

How to Apply

Application materials with instructions may be obtained from the Graduate College or from any graduate department. Only one application form is needed to apply for any of the types of financial aid listed on page 35, except the Defense Education Act Title VI Fellowships. The latter application may be obtained from Professor Angelina R. Pietrangeli, Chairman of the Committee on NDFL Fellowships, 223 Lincoln Hall, Urbana, Illinois 61801.

To be considered for a University Fellowship beginning in June or September, the application must be filed with the major department no later than February 15. Applications for tuition and fee waivers and assistantships are accepted after that date, but applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer assistantships at the same time they consider applications for fellowships. An age limit of thirty-five years applies to applicants for University Fellowships and Tuition and Fee Waivers.

Announcement of Awards

Fellowship awards are announced by the Graduate College on or about April 1. Recipients are expected to accept or decline by April 15.

The University of Illinois adheres to the following resolution adopted by the members of the Association of American Universities and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom to reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

Loan Funds

Long-term loan funds are available to those students who have a demonstrated financial need. The amount of loan that is finally approved by the University Committee on Loans is subject to the availability of funds, and no commitment is made until all financial information has been reported in the application.

The signature of a qualified endorser or security in the form of collateral satisfactory to the Bursar's Office is required for all long-term loans, unless otherwise provided by terms of the loan fund or waived in meritorious cases, as determined by the Director of Student Financial

Aids and the Bursar's Office. Each application must be approved by the Dean of the Graduate College.

Students must be in good standing before an application is accepted for processing. If loans are made over a two-semester period, the student must remain in good standing to receive a second advance. Any exceptions to this rule must be requested from the Student Loan Office.

Applications may be secured from the Bursar's Office, 100b Administration Building, and the Student Loan Office, 346 Student Services Building.

ACADEMIC AND OTHER REGULATIONS

A student should familiarize himself with the academic requirements and regulations of the Graduate College and of the department in which he is working. He is responsible for complying with these regulations and for fulfilling all requirements for his particular degree. Every graduate student should have a Graduate College catalog and, if available, a departmental bulletin. The Graduate College calendar included in this catalog is also printed separately and may be obtained from the Graduate College Office, 330 Administration Building.

Petitions

The normal procedures and requirements of the Graduate College are indicated in this catalog. A student may petition to the Dean of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms for such petitions may be secured at the Graduate College Office.

Military Deferment

Students being deferred from military service for educational purposes periodically must file a "Status Form" with the Office of Admissions and Records so that accurate information will be available when local boards request reports. Students must immediately file any change in their status with this office. Copies of the "Status Form" may be obtained from the Office of Admissions and Records, 69 Administration Building, from the departmental offices, or from the Graduate College Office.

Residence

Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable portion of his time to graduate studies. A student who is regularly employed outside the Urbana-Champaign community is not considered to be in residence even though he is registered in a campus course.

Work Completed Elsewhere

A candidate for the doctorate, who has received a master's degree from a recognized institution, receives the equivalent of eight units of credit for that work. If such credit is to be used in partial fulfillment of the requirements for the doctorate, he is examined on the content of the courses involved at the time of the preliminary examination.

A student who has completed graduate work in a recognized institution, but without receiving a degree, may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for an advanced degree.

Time Limit for Advanced Degrees

A candidate for the master's degree must complete all requirements for the degree within five calendar years after his first registration in the Graduate College.

A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in the following paragraph.

A candidate for the doctorate who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. A student whose program of study is significantly interrupted after he receives a master's degree from the University of Illinois and who later returns to work for his doctorate will have five years from the date he returns to complete degree requirements.

Advisers

Every graduate student must have an adviser in the department or school in which he is a degree candidate. The adviser's primary duty is to assist in planning a program of graduate work which fits the needs of the student and satisfies departmental and Graduate College requirements. A new student should go to his major department to discuss the selection of an adviser.

Unit Credit for Courses

Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five. The normal program for an eight-week summer term is two units; the maximum permissible is two and one-half units.

Grades

Grades are recorded by letters as follows: for thesis research and non-credit seminars, S and U (satisfactory and unsatisfactory); for courses, A, B, C, D, and E (failure). A student who receives as much as two but *less* than three units of grades below B must replace such units with additional units of A or B grade to qualify for an advanced degree. Three units of grade below B disqualify a student as a degree candidate.

Maximum and Minimum Registration

Students holding University Fellowships or other fellowships awarded by the University must carry a full program (four units or the equivalent). Those awarded tuition and fee waivers must carry a minimum program of three units or the equivalent. The academic work carried by assistants and others on the University staff is limited by statute, and those employed outside the University are expected to reduce their programs of study in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Terms of Employment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1¼ units
Two-thirds time	2¼ units	1½ units
One-half time	3 units	1¾ units
One-third time	3¾ units	2 units
One-fourth time	4 units	2 units

Exceptions to the *semester* schedule are possible by means of a special petition procedure. This privilege does not apply to summer session.

Conferring of Degrees

Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August. No more than two graduate degrees will be conferred for work completed at the University of Illinois.

THE MASTER'S DEGREE

Master's degrees are offered in the fields indicated on pages 8 and 9. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units. Three of the eight units must be in courses numbered in the 400 series, and two of these three must be in the major field.

Residence

A candidate must spend at least two semesters, or the equivalent, in residence and must earn at last half the required units while in residence.

Major Requirement

At least four units of work must be in the area of concentration. The remaining credit may be in that field or in other courses appropriate to the student's educational goals.

Thesis

A student electing or required to write a master's thesis should file the subject of the thesis at the Graduate College Office at least six weeks prior to graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research can not be applied to a degree unless a thesis is submitted.

For specific instructions regarding the format of the thesis, the student should obtain a copy of the leaflet, *Instructions for Preparation of Theses,* from the Graduate College Office.

Master's Degree in Teacher Education

Programs leading to the master's degree for teachers are available in the areas listed below. Students are eligible if (1) they have completed all the requirements of a four-year undergraduate curriculum for teachers, and if (2) they are otherwise eligible for admission to graduate study in the departments administering these programs.

Agricultural Education—page 58
Art—page 74
Biological Sciences and General Science—page 215
Chemistry—page 92
Commercial Teaching—page 87
English—page 155
French—page 168
Geography—page 173
German—page 181
Health Education—page 183
Home Economics—page 192
Latin—page 111
Mathematics—page 245
Music—page 265
Physical Education—page 281
Physical Sciences—page 283
Physics—page 283
Russian—page 310
Social Studies—page 313
Spanish—page 324
Speech—page 328
Speech Correction—page 328

In addition to the curricula listed above, programs leading to the master's degree in education with emphasis in a number of teaching fields are described on page 128.

Programs Leading to the Master's Degree and Teacher Certification

The above programs also are available to students who have not met all the requirements of a four-year undergraduate curriculum for teach-

ers, but who wish to take the fifth year of work for a master's degree. The transcript of the applicant is evaluated for the purpose of determining the courses necessary to fulfill teacher certification requirements as well as master's degree requirements. The admission of such students to graduate study in departments other than Education requires the approval of the appropriate adviser and of the Coordinator of Teacher Education.

Those who have not completed student teaching must do so in order to be eligible for the teacher education master's degree. The usual criteria for admission to student teaching are applicable. For more detailed information, see "Council on Teacher Education, Student Teaching," in the Undergraduate Study catalog. Normally, the student admissible to graduate study will have met the grade-point average required for admission to student teaching. However, at least one semester of study at the Urbana campus must have been completed with satisfactory grade-point average before a student may be admitted to student teaching. The candidate must register concurrently in technic of teaching (the methods course) and educational practice (student teaching) for undergraduate credit.

Students who have not previously completed an undergraduate course in educational psychology may take a proficiency examination in Educational Psychology 211. A successful proficiency examination or passing grade in educational psychology is required for admission to Educational Psychology 311 and 312.

Normally, professional education requirements for certification will have been fulfilled by a program which includes the following courses:

Educational Psychology 211 (or equivalent)	3 semester hours
Elementary Education 231 or Secondary Education 241	3-5 semester hours
Educational Practice 232 or 242	5 semester hours
History and Philosophy of Education 304	½ unit
History and Philosophy of Education 305	½ unit
Educational Psychology 311	½ unit
Educational Psychology 312	½ unit

It should be noted that only 300- and 400-level courses may apply toward the master's degree.

The student must also meet the general education and teaching field requirements prescribed in the appropriate undergraduate curricula for teachers. Students pursuing both certification and master's degree requirements, as described above, should anticipate at least the equivalent of three semesters of full-time study.

THE DEGREE OF DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered in the fields indicated on pages 8 and 9. The general requirements for this degree are

described below and any special requirements are given in the departmental listings. For information concerning professional degrees at the doctoral level in business administration, education, law, and music, see the appropriate departmental sections.

Residence

A doctoral program includes three stages of progress, as defined below. At least two of these stages must be completed in residence and this period in residence must include two successive semesters in the second or the third stage.

The first stage is completed when the candidate has received a master's degree or has earned the equivalent number of credits (eight units or thirty-two semester hours); *the second stage* consists of eight units of work, fulfillment of the major and minor course requirements, the language requirements (if not completed earlier), and a successful preliminary examination; *the third stage* is devoted to research and seminars (eight units), the preparation of the dissertation, and the final examination.

It is possible to complete these three stages in three years if the student devotes full time to his academic program. For information concerning the maximum time allowed, see page 38.

Major and Minor Subjects

A candidate is expected to declare a major field of study and one minor (requiring four units) or two minors (requiring two units each). If he elects two minors, only one of them may be a division of the major department or field; a full minor must be entirely outside the department offering the major. The requirements for a minor in any field should be checked with the department concerned.

Language Requirements

A candidate must demonstrate ability to read two of the following languages: French, German, Russian. A student who plans to become a candidate for the Doctor of Philosophy degree should qualify in at least one of the required foreign languages during his first year of graduate study. A student must apply to take the examination in French, German, or Russian well in advance of the examination date. (See pages 10 to 15 for deadlines.) The entire language requirement should be satisfied early in the doctoral program, in any event no later than two months before the preliminary examination, or during the semester (or summer session) preceding admission to the preliminary examination.

Students may satisfy the language requirement by (1) direct examination, or (2) obtaining grades of A or B in French, German, or Russian

401; however, those majoring in history or philosophy must meet this requirement by direct examination. A student is not permitted to take the direct examination in any language more than twice. Certification of proficiency in foreign languages from other colleges or universities is not accepted by transfer.

Doctoral Committee

A permanent doctoral committee to conduct the preliminary and final examinations is appointed by the Dean of the Graduate College upon recommendation of the executive officer of the department in which the student is doing his major work.

Preliminary Examination

A candidate for the doctor's degree must pass a preliminary oral examination to test his knowledge of his major and minor fields of study. He is not admitted to the examination until (1) he has fulfilled the language requirement; (2) he has satisfactorily completed at least sixteen units of graduate work; and (3) the departments of his major and minor fields of study consider, as a result of written examination or otherwise, that he has adequate preparation.

Thesis

The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination. After passing this examination, the candidate *must* register each term (summer sessions excluded) until he receives his degree. When the credit requirement is satisfied—eight units of thesis research subsequent to passing the preliminary examination—the student maintains his status as a candidate by registering for zero credit in Thesis Research (499).

Directions regarding the format of the thesis are given in the leaflet, *Instructions for Preparation of Thesis,* which may be obtained in the Graduate College Office. The candidate must submit to the Graduate College, no later than the date specified in the current calendar, (1) the original and first carbon copy (or two copies reproduced by an approved method) of his thesis, and (2) one typewritten copy of an abstract not exceeding six hundred words.

Each candidate who passes the final examination must pay a $25.00 microfilm fee. This provides for (1) microfilming the complete thesis, with one copy deposited in the University of Illinois Library, and (2) publication of the abstract in *Dissertation Abstracts.*

Final Examination

After the credit requirements for the third stage have been satisfied, and the thesis completed, the candidate is admitted to the final examination upon recommendation of the major department.

SPECIAL EDUCATIONAL OPPORTUNITIES

Traveling Scholar Program

The University of Illinois is one of eleven midwestern member universities of the Committee on Institutional Cooperation and a participant in the Committee's Traveling Scholar Program. This program enables an advanced graduate student to work at another campus for a semester in order to take advantage of special course offerings or research facilities, such as a unique laboratory or library collection, not available at his own institution. A CIC Traveling Scholar registers at his home university, and credit for the work is recorded there. Appointment as a Traveling Scholar is based upon the individual submission to the Graduate College of an application which carries the strong endorsement of the student's major department and the approval of the host institution. Each university retains the right to accept or reject any student desiring to study under its auspices. A student interested in participating in the program should consult with the head of his major department.

Auditing Privileges

A graduate student or a person not registered in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a form bearing the approval of the instructor and the Dean of the Graduate College is filed with the Records Office, 69 Administration Building. A student should not enter on his program card any courses which he plans to attend as an auditor.

Extramural Courses

Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor more than one unit in any combination of extramural and campus courses.

Because extramural course work is not considered work in residence, credit earned in such courses can be applied toward an advanced degree only if (1) the courses are approved in advance by the adviser and constitute part of a well integrated program, and if (2) the total extramural credit does not exceed two units (the Ed.M. and the Advanced Certifi-

cate excepted). Credit earned in extramural courses can not be applied toward the second stage of a doctoral program (see page 42).

Correspondence Courses

Credit earned in correspondence courses can not be applied toward an advanced degree. However, it is possible to fulfill certain prerequisites or remove deficiencies through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 104 Illini Hall.

Fields of Instruction

Courses open to graduate students are of two types. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only. Those numbered 500 to 599 are open only to graduate students in certain professional programs.

All courses for graduate students require previous preparation. By consultation with the instructor, a student may determine whether he has had the necessary prerequisites for a particular course.

Courses in this catalog are listed alphabetically by departments. The offerings in each field are arranged numerically in groups, with headings to indicate the students for whom they are designed. The 400 series are listed first; courses in the 300 series follow. After the title of each course is a brief description of its contents, the credit given, and the requirements for admission to the course.

A number of courses offer variable credit. At the 300 level, additional work in the nature of special reports, papers, or projects is required of a student who registers for the maximum credit shown. In each case, the student, with help of his adviser, determines whether or not his schedule allows sufficient time to complete the work required for maximum credit.

At the 400 level, research, reading, and independent study courses provide variable credit; proportionate time devoted to a particular activity can thus be indicated on the student's record.

Unless otherwise specified, it can be assumed that a course is offered at least once during each calendar year. Courses offered only in the summer session are indicated by "S"; courses given in alternate years are indicated with the year of offering. A complete listing of courses for each term is contained in the Time Table, published about six weeks prior to the beginning of each term and available from the Graduate College, 330 Administration Building.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the Master of Science and Doctor of Philosophy in Accountancy and to the Master of Accounting Science.

A student who applies for admission to graduate study in accountancy must have a grade-point average of 3.75. He must have had the equivalent of the undergraduate curriculum at the University of Illinois, including twenty hours of undergraduate work in accountancy (twenty-four hours for M.A.S. candidates), courses in economic theory and the functional areas of business, two courses in statistics, courses in finite mathematics and calculus, and a course in or knowledge of computer programming and applications. In addition, he must take or have credit (graduate or undergraduate) in linear algebra and operations research.

Master of Science. A candidate for the Master of Science degree must complete eight units of graduate work, of which at least six must be at the 400 level. A candidate must have at least five units in accountancy, two of which must be earned by the satisfactory completion of a master's thesis. The remaining three units may be taken in accountancy or in other fields, including one or more minors, subject to the approval of the graduate adviser.

Master of Accounting Science (professional degree). This program is designed for candidates who wish to prepare for professional careers in public, governmental, or industrial accounting. Candidates for the M.A.S. degree must have had twenty-four hours of undergraduate work in accountancy (instead of twenty hours), including a course in each of these areas: cost accounting, federal income tax accounting, advanced accounting, accounting system design, and auditing.

A candidate for the M.A.S. degree must complete eight units of graduate credit. No thesis is required. Four of the eight units of graduate credit must be taken in accountancy courses. In addition, one or more minors of one to four units in a field or fields outside of the area of accountancy are required. Programs may be developed for those intending to enter public accounting or accounting positions in non-profit organizations, institutions or governmental agencies, or accounting careers in industrial or commercial enterprises. Course elections made by the student under these options are subject to the approval of his adviser.

Program for Non-Commerce Graduates. A program is available which permits non-commerce graduates to earn a Master of Science in Accountancy or a Master of Accounting Science degree in approximately two years. Students with undergraduate degrees, but with no undergraduate work in accountancy, may remove entrance deficiencies during the first year by registering in the combined courses, which carry no graduate credit. These students then proceed with the regular graduate program during the second year of residence.

Doctor of Philosophy. A candidate for the Doctor of Philosophy degree must meet the prerequisites for graduate study in accountancy, stated above, and his admission must be approved by the departmental admissions committee which may require an oral or written examination.

The requirements for the Doctor of Philosophy degree include a master's degree, credit in micro- and macro-economics, a minor or minors of at least four units in fields other than accountancy, at least eight units in accountancy, including not less than six units taken for graduate credit at the University of Illinois, and additional units to bring the total to at least twenty-four, including those taken for a master's degree. Eight of the twenty-four must be doctoral dissertation units. The doctoral program of each student, including the selection of an appropriate minor or minors, must be approved by the graduate adviser.

The candidate is required to pass examinations in two foreign languages, an oral and written preliminary examination prior to dissertation research, and an oral final examination on his doctoral dissertation. In his preliminary examination the

candidate must demonstrate a thorough knowledge of accounting theory and of the areas of accountancy in which he specialized, a general acquaintance with the subject matter and bibliography of other areas of accountancy, and proficiency in his minor fields.

Requests for further information about any of the programs described above should be addressed to the head of the department, 360 Commerce and Business Administration Building (West).

GRADUATE FACULTY

Professors: E. J. DeMaris (Head of Department), N. M. Bedford, R. I. Dickey, H. P. Holzer, Dorothy Litherland, G. E. Lukas, R. K. Mautz, C. A. Moyer, K. W. Perry, R. E. Schlosser, D. H. Skadden, W. E. Thomas, N. D. Wakefield, A. R. Wyatt, V. K. Zimmerman.

Associate Professors: G. D. Brighton, P. E. Fess, H. M. Schonfeld.

Assistant Professors: C. G. Blough, D. J. Casler, M. Uretsky, C. Weber.

PROFESSIONAL COURSES

566. **Accounting Problems of Industrial Management.** A development of the role and importance of cost and revenue data in the process of enterprise administration. Attention is focused on the goals of the firm and the possible aid in achieving these goals that would come from properly conceived, prepared, and utilized cost and revenue data. For Master of Accounting Science and Master of Business Administration students only. 1 unit. Schonfeld.

577. **Professional Problems.** Instruction as to types and methods of solution of professional problems in public accounting, including practice in analyzing and solving a wide variety of such problems. For Master of Accounting Science students only. 1 unit. Perry, Skadden.

594. **Methods and Practices in Professional Research.** Instruction in research methods, materials, and techniques together with individual practice in conducting and reporting on specific professional research projects. For Master of Accounting Science students only. 1 unit. Casler, Zimmerman.

COURSES FOR GRADUATES

432. **Accounting Under Different Social Systems.** An inquiry into the ways accounting has been adapted to the needs of different social systems; the extent of its contribution; its apparent limitations. Consideration is also given to the relationship between accounting and the growth and development of social systems. 1 unit. Prerequisite: Consent of instructor. DeMaris.

441. **State and Federal Accounting Theory.** Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. 1 unit. Lukas.

455. **Macro-Accounting.** Same as Economics 425. An examination of the fundamental concepts underlying the attempts to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor. DeMaris, Zimmerman.

461. **Administrative Accounting.** Accounting as a tool for management; organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. 1 unit. Holzer, Thomas.

466. **Cost Accounting Theory and Analysis.** A critical examination of cost accounting methods as to truth and expediency. 1 unit. DICKEY, HOLZER.

471. **Accounting Reports.** Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. 1 unit. WAKEFIELD.

472. **Auditing Standards and Techniques.** A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. 1 unit. MAUTZ, MOYER, WYATT.

473. **The Theory of Accounting System Design.** Problems and procedures in connection with designing and installing accounting systems. 1 unit. SCHLOSSER, THOMAS.

474. **Income Tax Development.** A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. 1 unit. BRIGHTON, SKADDEN.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. 1 unit. BEDFORD, MAUTZ, MOYER, WYATT.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. 1 unit. BEDFORD, FESS, MAUTZ.

484. **The Accounting Theory of Business Income.** An examination of the development and essential characteristics of the accounting theory of business income evaluated in the light of criticisms implicit in other concepts of income; the social significance of business income theory. 1 unit. MAUTZ.

485. **Relationship of Accounting Theory to Philosophy, Science, and Other Disciplines.** An examination of the relationship of accounting theory to the developments, thoughts, and methods in the fundamental intellectual disciplines. 1 unit. BEDFORD.

487. **Surplus and Dividends.** The theories underlying the treatment of balance sheet items deserve close consideration in accounting, because the balance sheet reflects the effect of conflicting ideas about the bases for setting up restrictions on the freedom of directors to dispose of corporation assets as dividends. 1 unit. PERRY.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. 1 unit. ZIMMERMAN.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. 1/4 to 2 units. STAFF.

499. **Thesis Research.** Individual direction and guidance in writing theses, and seminar discussions of progress made. 0 to 4 units. DICKEY, WAKEFIELD, STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. 3/4 unit. Prerequisite: Accountancy 106 or 166, and 108; an average of C or better in preceding courses in accountancy. BEDFORD, CASLER, PERRY, WAKEFIELD.

325. **Accounting System Design.** An introduction to the fundamentals of accounting system design. This includes the design and use of business papers, records, and reports; the functions of business machines in accounting systems; and personnel

problems in accounting system design. ¾ unit. Prerequisite: Accountancy 308. Schlosser, Weber.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. ½ unit. Prerequisite: Accountancy 108. Brighton, Lukas.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. ¾ unit. Prerequisite: Accountancy 108. Holzer, Schonfeld, Thomas.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. Dickey, Holzer, Schlosser, Schonfeld.

371. **Auditing.** Nature of audit evidence, basic audit techniques, audit practices and procedures, professional ethics, audit reports. ¾ unit. Prerequisite: Accountancy 308. Fess, Mautz, Wakefield.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. ¾ unit. Prerequisite: Accountancy 371. Fess, Wyatt, Zimmerman.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. ¾ unit. Prerequisite: Accountancy 274 and 308. Brighton, Skadden.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. 1 unit. Prerequisite: Credit or registration in Accountancy 371. Casler, Lukas, Perry, Wyatt.

378. **Advanced Theory and Practice.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory, auditing, ethics. 1 unit. Prerequisite: Accountancy 377. Perry, Wyatt.

ADVERTISING

The Department of Advertising offers graduate work leading to the Master of Science in Advertising. For the program leading to the Doctor of Philosophy in Communications, see page 112; for programs leading to doctoral majors and minors in related fields such as marketing and psychology, consult the departmental listings.

Admission to graduate study in advertising requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in advertising or a related field, English, commerce, or the other social sciences, and (2) a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science. Requirements for this degree include:

(1) A major of four units, or three units and one additional unit approved by the adviser. Candidates must select at least two units from Advertising 481, 482, and 483. Advertising 382, 383, and 384 also must be included in the master's program, unless these courses, or the equivalent, were previously taken.

(2) A minimum of two units outside of the department.

(3) A thesis of one or two units; or in lieu of thesis and with the consent of the head of the department, a minimum total of nine units including no less than one-half unit of Advertising 490.

(4) A minimum of four units of credit at the 400 level.

(5) A minimum total of eight or nine units depending upon the conditions followed in number (3) above.

GRADUATE FACULTY

Professors: C. H. SANDAGE (Head of Department), L. W. MCCLURE.
Associate Professors: J. E. MOYER, H. W. SARGENT.
Assistant Professors: A. M. BARBAN, J. L. SIMON.

COURSES FOR GRADUATES

481. **Advanced Advertising Principles.** Same as Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Advertising 481 and 388. 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. SIMON.

483. **Advertising and the Mass Media.** Same as Communications 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit. MOYER.

484. **Advertising and Consumer Behavior.** An examination of consumer behavior as a means of shaping the communications message; use of the behavioral sciences in creative communication strategy. 1 unit. BARBAN.

490. **Special Topics in Advertising.** ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

499. **Thesis Research.** 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. ½ unit. MOYER.

382. **Advertising Copy and Layout.** Theory and practice of advertising; message creation and arrangement for print and broadcast media; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. 1 unit. Prerequisite: Advertising 281. SARGENT.

383. **Advertising Media.** Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. ½ unit. Prerequisite: Advertising 281. BARBAN, MOYER.

384. **Advertising Campaigns.** Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements—copy and layout. ½ unit. Prerequisite: Advertising 382 and 383. MOYER.

385. **Advertising Promotion and Sales.** Sales problems, advertising promotion, advertising research, market research. ½ unit. Prerequisite: Advertising 281. MCCLURE.

386. **Radio and Television Advertising.** Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques, including merchandising, marketing, servicing, and sales; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. ½ unit. Prerequisite: Advertising 281. MCCLURE.

387. **Advertising Policies and Problems.** Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to

management decision-making problems at the national level. ½ or 1 unit. Prerequisite: Advertising 281. WEDDING.

388. **Advertising in Contemporary Society.** A study of advertising as an institution and its role in communications, society, our economy, and business. Students may not receive graduate credit for both Advertising 388 and 481. ½ unit. Prerequisite: Advertising 281. SARGENT.

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautical and Astronautical Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy. Study and research are planned to prepare graduates for fundamental and applied work in airplane, missile, and space flight engineering. Typical areas of concentration are aerodynamics, aeroelasticity, astrodynamics, propulsion, structural mechanics, and guidance and control.

The minimum grade-point average for admission to graduate study in aeronautical and astronautical engineering is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The prerequisite for graduate study in aeronautical and astronautical engineering normally is the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical and astronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical and astronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Each student plans his study program in consultation with a departmental adviser. Courses offered by departments other than aeronautical and astronautical engineering may be included in the major area of study when these courses are of particular value to the work which students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical and astronautical engineering must have taken mathematics through the first course in differential equations and the undergraduate aeronautical and astronautical engineering courses, or their equivalents, which are prerequisities to study in the area of the minor work. Deviation from these requirements requires approval from the head of the department.

For information concerning applied mathematics, see page 253.

GRADUATE FACULTY

Professors: H. S. STILLWELL (Head of Department), B. L. HICKS, H. H. HILTON, H. W. KNOEBEL, R. W. MCCLOY, A. I. ORMSBEE, R. A. STREHLOW, S. M. YEN.

Associate Professors: H. O. BARTHEL, Y. M. LIN, A. R. ZAK.

Assistant Professor: C. E. BOND.

COURSES FOR GRADUATES

411. **Advanced Aerodynamics of Compressible Fluids.** Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. 1 unit. ORMSBEE.

414. **Boundary Layer Theory.** Theories of the boundary layer of a compressible fluid and their solutions, laminar and turbulent; boundary layer in hypersonic flow. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 and 232, or equivalent. YEN.

415. **Wing Theory.** Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. 1 unit. Prerequisite: Mathematics 346 or equivalent. ORMSBEE.

416. **Hypersonic Aerodynamics.** Discussion of high Mach number flows including the aerodynamic effects of dissociation and ionization. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 411. ORMSBEE.

418. **Theory of Rarefied Gas Flows.** Application of kinetic theory to rarefied gas flow problems; free-molecule flow; near free-molecule flow; linearized problems; flows with appreciable deviation from equilibrium. 1 unit. Prerequisite: Physics 362. YEN.

426. **Theory of Continuous Media.** Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. 1 unit. Prerequisite: Consent of instructor. HILTON.

427. **Thermal Stresses and Creep Buckling.** Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; minimum weight and probability of failure; applications to high-speed airplane, missile, and space vehicle structures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or consent of instructor. HILTON, ZAK.

428. **Theory of Large Deformations in Nonlinear Continuous Media.** Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications: generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, constituent relations for inelasticity. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or equivalent. HILTON.

429. **Theory of Linear and Nonlinear Viscoelasticity.** Fundamental concepts of viscoelasticity with applications. Elastic-viscoelastic analogies, creep and relaxation functions, thermo-mechanical reciprocity relations, variational principles, model fitting, shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, torsion of nonlinear bars and shells. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or consent of instructor. HILTON.

434. **Aerodynamic Heating.** Theory of convective aerodynamic heating in high-speed flow, laminar and turbulent flows; ablation, transpiration cooling, and mass transfer cooling; aerodynamic heating in hypersonic flow, real gas effects, effect of pressure interactions and vorticity interactions; heat transfer in rarefied gas flows. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 and 232, or equivalent. YEN.

438. **Fundamentals of Combustion.** Same as Mechanical Engineering 403. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-

dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 or Mechanical Engineering 305. STREHLOW.

451. **Aeroelasticity and Aeroinelasticity.** Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250 or consent of instructor. ZAK.

452. **Stochastic Structural Dynamics.** Fundamentals of stochastic analysis and generalized harmonic analysis. Stationary and nonstationary processes in linear systems; applications to panel vibrations induced by boundary layer turbulence and jet noise; applications to gust and landing problems; peak distributions and fatigue life; stabilities of stochastic systems; acoustical damping and apparent mass; response of nonlinear structures to random inputs. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250 or Theoretical and Applied Mechanics 412, or equivalent. LIN.

490. **Seminar.** Presentation by graduate students and staff of current topics in the fields of aeronautics. No credit. Prerequisite: Graduate standing in aeronautical and astronautical engineering. HILTON.

493. **Special Problems.** Theoretical and experimental investigations of problems in airplane, missile, and space flight engineering. 1 to 2 units. STAFF.

499. **Thesis Research.** Research in the various areas of the aeronautical and astronautical sciences. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Human Factors in Engineering for Space Travel.** Same as Physiology 304. Human factors decisive in the design and operation of manned space vehicles. ½ unit. Prerequisite: Graduate standing in biology, engineering, physical sciences, or psychology. R. E. JOHNSON, STILLWELL.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE, STILLWELL.

317. **Elements of Magnetohydrodynamics.** Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, magnetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and crossed-field flows, theory of characteristics, MHD acceleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 or consent of instructor. BOND.

334. **Rocket Propulsion and Rocketry.** The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. ½ unit. Prerequisite: First course in thermodynamics or consent of instructor. MCCLOY.

391. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. ½ or 1 unit. Prerequisite: Consent of instructor. STAFF.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the Master of Science and Doctor of Philosophy. Fields of specialization include farm management, land economics, agricultural prices and marketing, agricultural finance, agricultural policy, international comparative agriculture, consumption economics, agricultural law, and rural sociology.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the Bachelor of Science in Agriculture at the University of Illinois, including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least eight hours in accountancy, business law, finance, history, management, marketing, political science, or sociology.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The grade-point average required for admission to graduate study in agricultural economics is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

A candidate for the Master of Science degree is required to register for at least two units of economics, including one unit of economic theory. For the Doctor of Philosophy degree, a candidate must complete: (1) a minimum of five units in the social sciences other than agricultural economics, including three units in economic theory of which two must be selected from Economics 400, 401, 402, and 403, and the third from any 400-level course in economic theory offered by the Department of Economics; (2) at least one unit in each of three areas of agricultural economics: production and resource organization, agricultural economic policy, prices and markets (Agricultural Economics 404, 405, and 436); and (3) two and one-half units in analysis and measurement, including at least one-half unit of operations research (Economics 374), one unit of mathematics (Mathematics 358 and 359), and one unit of inferential statistics (Agricultural Economics 441). Equivalent courses completed at another institution will be accepted in fulfillment of these requirements, subject to Graduate College regulations.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics is considered a first minor, in which case the program in that minor requires the approval of the Department of Economics.

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economics and agricultural subjects.

GRADUATE FACULTY

Professors: H. G. Halcrow (Head of Department), C. B. Baker, R. W. Bartlett, G. K. Brinegar, E. E. Broadbent, W. D. Buddemeier, F. Dovring, C. L. Folse, H. W. Hannah, T. A. Hieronymus, J. M. Holcomb, G. G. Judge, R. A. Kelly, N. G. P. Krausz, D. E. Lindstrom, R. J. Mutti, F. J. Reiss, R. G. Spitze, E. R. Swanson, W. N. Thompson, R. N. Van Arsdall, V. I. West, J. E. Wills.

Associate Professors: J. C. Headley, J. H. Herbst, M. B. Kirtley, S. C. Schmidt, H. J. Schweitzer.

Assistant Professors: L. P. Fettig, D. G. Smith.

Agricultural Economics

COURSES FOR GRADUATES

401. **International Comparative Agriculture.** Agricultural and food problems of the world and of selected countries viewed in the world setting; resources and institutional factors affecting production; national and international policies and plans for developing agricultural production and improving levels of living. Emphasis is given to a comparative approach to agricultural development of countries on different economic levels. 1 unit. Dovring.

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. 1 unit. Prerequisite: Economics 300 or an equivalent course in economic theory and one course in statistics. Swanson.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. 1 unit. Prerequisite: One semester of graduate work or consent of instructor. Halcrow, Schmidt.

406. **Research Methodology in Agricultural Economics.** Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. 1 unit. Prerequisite: Economics 400 or 401, or a course of comparable level in the basic field related to the student's research. Baker.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. Field trip; estimated expense, $8.00. 1 unit. Wills.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of government agencies; cooperative efforts. 1 unit. Brinegar, Hieronymus.

441. **Agricultural Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. 1 unit. Prerequisite: An elementary course in statistics. West.

442. **Quantitative Analysis in Agricultural Economics.** Application of techniques of quantitative analysis in agricultural economics; construction, estimation, and interpretation of sector, spatial, and input-output models for the agricultural economy. 1 unit. Prerequisite: Agricultural Economics 441, Economics 401, Mathematics 358, or equivalents. Judge.

470. **Seminar in Family and Consumption Economics.** Same as Home Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in statistics; Agricultural Economics 370 or consent of instructor. Dunsing.

491. **Seminar and Special Topics.** Each graduate student majoring in agricultural economics must register for this course. Only students who register for credit and complete special studies under the direction of one or more staff members receive credit. 0 to 2 units.

499. **Thesis Research.** Individual research under supervision of members of the graduate teaching staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Financing Agriculture.** Capital and credit needs of farmers; agencies supplying credit; problems of borrowers and lenders. ¾ or 1 unit. Prerequisite: Economics 102 and 103, or 108. BAKER.

303. **Agricultural Law.** Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. ½ to 1 unit. HANNAH, KRAUSZ.

305. **Agricultural Policies and Programs.** The problems of agriculture as an industry and an analysis of past and current federal and state governmental policies and programs affecting agriculture; objectives and development of policies; the use of economic concepts in evaluating possible future agricultural policies and programs; and forces in policy formation. Field trip; cost, $7.00. ¾ or 1 unit. Prerequisite; Economics 108. SPITZE.

312. **Farm Appraisals.** Same as Agronomy 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. REISS, STAFF.

318. **Land Economics.** Physical, economic, and institutional factors that affect the role of land in economic life; population and resource requirements; principles of land utilization; returns from land; land value; property rights and tenure rights; social controls; rural and urban land development. ¾ or 1 unit. Prerequisite: Consent of instructor. DOVRING.

324. **Farm Operation.** Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. VAN ARSDALL, WILLS.

325. **Advanced Farm Management.** The functions of management; effects of goals and values on management decisions; use of economic analysis in farm production planning including resource allocation and valuation, and cost minimization. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. HEADLEY.

326. **Professional Farm Management.** Principles of farm management applied to the problems of those managing farms for others as a profession; development of the profession; relationships with clients and farm operators; division of inputs and returns between owner and operator; direct operation of farms with hired labor; case problems; business practices and procedures; professional ethics. Field trips to farms and professional farm management offices; estimated expense, $15.00. ¾ or 1 unit. Prerequisite: Credit or registration in Agricultural Economics 324; Agricultural Economics 325. HOLCOMB.

331. **Grain Marketing.** Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially futures markets; inventory management, operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or Marketing 101. HIERONYMUS.

332. **Livestock Marketing.** Same as Animal Science 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. BROADBENT.

334. **Marketing of Dairy Products.** Same as Dairy Science 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or Marketing 101 or twelve hours of dairy science or dairy technology. BARTLETT.

335. **Economics of Food Distribution.** Same as Horticulture 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. KELLY.

337. **Economic History of American Agriculture.** Same as Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. SCHWEITZER.

341. **Agricultural Statistics.** Statistical methods applied to agricultural economics including graphic presentation, frequency distribution, inference and probability, time series analysis, index numbers, analysis of variance, regression, and correlation. ½ unit. WEST.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. ¾ or 1 unit. Prerequisite: Economics 103 or 108. BRINEGAR, SCHMIDT.

370. **Family Economics.** Same as Home Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

Rural Sociology

COURSES FOR GRADUATES

407. **Population Studies and Demographic Analysis.** Same as Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections; relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

477. **Rural Community Organization and Development.** Same as Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of rural community organization; the process of community development as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117. LINDSTROM.

487. **Special Problems in Rural Sociology.** Same as Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

AGRICULTURAL EDUCATION

This program leads to the Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of vocational agriculture, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Educational Psychology 311 and 312 and two of the following courses: History and Philosophy of Education 301, 302, 303, 304. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall, Professor Lloyd J. Phipps, 357a Education Building, and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

The Department of Agricultural Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees with a major in agricultural engineering. The student may specialize in field power and machinery (soil dynamics, tillage and earthmoving, operations analysis, dynamics of particles and mechanisms, accelerated drying, and vehicle stability); soil and water mechanics (hydraulics of structures, agricultural hydrology, drainage, mechanics of erosion, and water resources planning); farm structures (structural analysis and design, environmental control, air contaminates, and waste disposal); or electric power and processing (system analysis for farmstead mechanization, crop processing, and physical properties of agricultural products).

The grade-point average required for admission to graduate study is 4.0 for the last sixty hours of undergraduate work; however, applications of those with averages below 4.0 but above 3.75 are reviewed individually by the departmental graduate committee and admission may be recommended if credentials are satisfactory.

Candidates for the master's degree must have the equivalent of the undergraduate curriculum at the University of Illinois.

Candidates for the Doctor of Philosophy shall fulfill all the standard requirements of the Graduate College as noted on pages 41 to 44. The program provides for a major in agricultural engineering with a minor in other graduate departments of engineering, mathematics, physics, including soil physics, or other disciplines in the physical sciences.

Opportunity for independent study and research is an important part of both the Master of Science and the doctorate programs. Research opportunities are available in both the Agricultural and Engineering Experiment Stations. For the master's degree, a thesis involving an analytical or experimental investigation and satisfying about one-fourth of the credit for the program is normally required.

Inquiries concerning graduate work should be directed to Frank B. Lanham, Head of the Department, 245 Agricultural Engineering Building.

GRADUATE FACULTY

Professors: F. B. Lanham (Head of Department), H. H. Beaty, E. L. Hansen, R. C. Hay, B. A. Jones, Jr., J. W. Matthews, J. A. Weber, R. R. Yoerger.

Associate Professors: W. Bowers, B. J. Butler, J. O. Curtis, D. R. Hunt, E. F. Olver, G. C. Shove.

Assistant Professors: H. P. Bateman, D. R. Daum, R. F. Espenschied, R. N. Fenzl.

COURSES FOR GRADUATES

400. **Research Orientation.** Discussion of the philosophy and methods of research, thesis preparation, and publication of research findings. No credit.

436. **Dynamics of Farm Machine Elements.** Advanced study of the dynamics of farm machine elements with specific reference to functional operation, stresses, and fatigue life. 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. Yoerger.

446. **Dynamics of Tillage, Traction, and Earthmoving.** Relationship of soil parameters to forces acting on tillage tools, earthmoving components, and traction devices; stress strain relationships in soil, failure patterns, and pulverization; speed effects, energy requirements, power trains, and model simulation. 1 unit. Prerequisite: Bachelor of Science degree in engineering or consent of instructor. Weber.

490. **Seminar.** Presentation and discussion of current research and literature in agricultural engineering. ¼ unit.

496. **Problems in Agricultural Engineering.** Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. 1 unit. Prerequisite: Consent of head of department. Staff.

499. **Thesis Research.** 1 to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** An agricultural problem with engineering implications is selected for study, investigation, and report wherein a satisfactory solution does not require a background in engineering education. For non-engineering students only. ½ unit. Prerequisite: Minimum grade-point average of 3.5; consent of instructor and head of department. Specific approval of the associate dean in advance of registration is required for a second special problems course. Staff.

311. **Instrumentation and Measurements.** Same as Mechanical Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science. Yoerger.

331. **Farm Machinery Technology.** Application, functional operation and management of tillage, planting, chemical application and harvesting machinery incorporating current engineering, agronomic and biological research results. For students presently in or preparing for teacher training or extension education. ¾ unit. Prerequisite: Agricultural Engineering 112 or 221. Yoerger.

336. **Design of Agricultural Machinery.** Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. ½ unit. Prerequisite: Mechanical Engineering 224. Hunt.

346. **Tractors and Prime Movers.** Engineering aspects of design and application of tractors for farm, construction, and military use; thermodynamics of engines, turbines, and other power units; measurement of power and efficiencies, transmis-

sion of power, traction, stability, and hydraulic circuity. ¾ unit. Prerequisite: Mechanical Engineering 209, Agricultural Engineering 146, or equivalent. WEBER.

356. **Soil Conservation Structures.** Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops, and practices in soil conservation and flood control. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235; Agricultural Engineering 277 or equivalent. FENZL.

357. **Land Drainage.** The design, construction, performance, and maintenance of surface tile and open ditch drainage systems. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235. JONES.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ¾ unit. HANSEN.

376. **Advanced Design of Farm Structures.** Timber, steel, and concrete building design, with emphasis on structures for agricultural production. ½ unit. Prerequisite: Civil Engineering 262; Agricultural Engineering 277 or equivalent. CURTIS.

381. **Electro-Mechanical Agricultural Systems.** Application of electric power and mechanical equipment to livestock production, crop conditioning, and materials handling systems for efficient use of time, power, and labor. Principles of planning materials handling systems; requirements for environmental control in agricultural production; electric controls circuits; and factors affecting drying, cooling, and processing of crops. ¾ unit. Prerequisite: Agricultural Engineering 281 or graduate standing in agriculture. OLVER.

387. **Agricultural Process Engineering.** Principles, design factors, equipment, and controls of systems for drying, refrigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. ½ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. SHOVE.

396. **Special Problems.** An agricultural problem is selected for study, investigation, and report wherein a satisfactory solution requires a strong background in engineering education. ½ unit. Prerequisite: Senior standing in engineering. STAFF.

AGRONOMY

The Department of Agronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop production, biometry, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis, morphology and classification, management, physical and colloidal chemistry, physical edaphology, physics.

The student must show promise of achievement in his chosen field, must have a grade-point average of 3.75 or higher for the last sixty semester hours of work completed, and must be approved by the Department of Agronomy. For students having grade-point averages below 4.0 but above 3.75, only those having unusually strong training in the basic sciences are considered for admission.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, microbiology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A pamphlet giving specific prerequisites and requirements may be obtained from the head of the Department of Agronomy.

A candidate for the Master of Science must present an acceptable thesis unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy.

GRADUATE FACULTY

Professors: M. D. Thorne (Head of Department), S. R. Aldrich, D. E. Alexander, A. H. Beavers, A. W. Burger, E. B. Earley, J. W. Gerdemann, J. E. Gieseking, H. H. Hadley, R. H. Hageman, J. B. Hanson, C. N. Hittle, A. L. Hooker, J. A. Jackobs, R. W. Jugenheimer, A. Klute, L. T. Kurtz, J. R. Laughnan, E. R. Leng, S. W. Melsted, R. T. Odell, J. W. Pendleton, M. B. Russell, W. O. Scott, F. W. Slife (Associate Head of Department), F. J. Stevenson, E. H. Tyner.

Associate Professors: C. M. Brown, J. B. Fehrenbacher, R. J. Miller, D. B. Peters, B. R. Sabey, R. D. Seif, R. O. Weibel, L. F. Welch, J. T. Woolley.

Assistant Professors: S. G. Carmer, R. L. Jones, R. J. Lambert, E. B. Patterson, E. C. A. Runge, C. M. Wilson.

COURSES FOR GRADUATES

400. **Seminar.** Discussions of current literature in crops and soils. Required of all graduate majors in agronomy. No credit. Staff.

402. **Chemical Properties of Soil: Their Relations to Soil Development and Plant Growth.** Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. 1 unit. Prerequisite: Agronomy 101 and Chemistry 101, 105, and 122, or equivalent. Miller.

403. **Genesis, Morphology, and Classification of Soils.** Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions; classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Agronomy 301 or consent of instructor. Fehrenbacher.

405. **Colloidal Chemistry of Soils.** Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Gieseking.

411. **Soil Physics.** The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Klute.

412. **Soil Organic Matter.** Basic considerations in organic matter transformation; geochemistry of organic matter; nature and origin of humic substances; reactions of organic matter in soils and sediments. Lectures, discussions, and assigned readings. Offered in 1967-1968 and in alternate years. 1 unit. Prerequisite: Agronomy 309 or consent of instructor. Stevenson.

422. **Pasture, Range, and Soil Conservation Research.** Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. 1 unit. Prerequisite: Agronomy 121, 321, or 322. Jackobs.

423. **Theory and Analysis of Plant Breeding Problems.** Genetics of crop plants; problems in selection and hybridization. 1 unit. Staff.

424. **Mineral Nutrition of Plants.** Same as Botany and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant com-

pounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

429. **The Evolution of Agricultural Economies.** Same as Anthropology and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. ALEXANDER, STAFF.

440. **Design and Analysis of Biological Experiments, I.** Same as Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. SEIF.

441. **Design and Analysis of Biological Experiments, II.** Same as Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 441. A continuation of Agronomy 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Agronomy 440 or equivalent. CARMER.

499. **Thesis Research.** 0 to 4 units.

(a) **Soils.** ALDRICH, BEAVERS, FEHRENBACHER, GIESEKING, JONES, KLUTE, KURTZ, MELSTED, ODELL, PETERS, RUNGE, RUSSELL, SABEY, STEVENSON, THORNE, TYNER, WELCH.

(b) **Crops.** ALEXANDER, BROWN, BURGER, CARMER, EARLEY, GERDEMANN, HADLEY, HAGEMAN, HANSON, HITTLE, HOOKER, JACKOBS, LAUGHNAN, LENG, PATTERSON, PENDLETON, SCOTT, SEIF, SLIFE, WEIBEL, WILSON, WOOLLEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Special Problems.** Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit for this course. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

301. **Soil Survey with Emphasis on Illinois Soils.** Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois and the cause of these soil differences; the influences of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative soils. Field trips; estimated expense, $10.00. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. RAY.

303. **Soil Fertility.** Influence of chemical and microbiological properties of soils on crop production; rhizobial fixation and other fertility effects of crop sequence; fertilizer needs, sources, materials, and applications. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. KURTZ.

304. **Soil Management and Conservation.** Influence of physical properties of soils on crop production; roles of drainage, tillage, crop sequence, and soil characteristics in land management. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. HINESLY.

309. **Intermediate Soil Science, I.** Genesis, organic matter, microbiology, and mineralogy of soils. This course, if followed by Agronomy 310, is intended to provide a science-based treatment of the field of soil science. Credit is not given for Agronomy 309 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100; Chemistry 122 and 133; Microbiology 100 and 101; two 200- or 300-level courses in plant science; credit or registration in Physics 101. KURTZ, STAFF.

310. **Intermediate Soil Science, II.** Soil fertility, soil physics, and soil-plant-atmosphere relationships. This course with Agronomy 309 is intended to provide a science-based treatment of the field of soil science. Credit is not given for Agronomy 310 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100; Chemistry 122 and 133; two 200- or 300-level courses in plant science; credit or registration in Physics 102 and Mathematics 132 or 133. KURTZ, STAFF.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent.

321. **Ecological and Physiological Factors Affecting Crop Production.** The environmental requirements of crop plants and their physiological bases; the adequacy of the environment provided by crop land in the United States as a function of management, soils, and climate; and distribution and yield of selected crops as a function of environment. ¾ unit. Prerequisite: Botany 100; Chemistry 132 or 133. HANSON.

322. **Forage Crops and Pastures.** Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. ½ unit. Prerequisite: Agronomy 121. JACKOBS.

323. **Principles of Plant Breeding.** Same as Horticulture 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, and the maintenance of high quality seed stocks. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. STAFF.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. ½ unit. Prerequisite: Agronomy 121. SLIFE.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Mathematics 365. A study of methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Students are expected to solve problems on the computers. 1 unit. Prerequisite: Mathematics 295 and a course in statistics or statistical methods or equivalent, or consent of instructor. CARMER.

377. **Diseases of Field Crops.** Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. Offered in 1967-1968 and in alternate years. ¾ unit. Prerequisite: Agronomy 204 or Plant Pathology 301. HOOKER.

ANIMAL SCIENCE

The Department of Animal Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Animal Science. Research may be pursued in the following areas of specialization: (1) population and immunogenetics, (2) physiology of reproduction including endocrinology, (3) animal nutrition, (4) nutritional biochemistry, and (5) meats technology. In addition, a student who expects to terminate the graduate program at the master's level may pursue work in animal production. Beef cattle, poultry, sheep, swine, and a wide variety of laboratory animals are available for use in conducting research in the above areas.

The minimum grade-point average for admission to graduate study in animal science is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Courses in biological and physical sciences and mathematics are essential preparation for graduate work in any specialized area of animal science. Candidates specializing in the areas of animal nutrition or nutritional biochemistry must have training equivalent to one five-hour course each in quantitative analysis and organic chemistry; a course in physical chemistry also is strongly recommended. Candidates specializing in meats technology should have undergraduate training in meat evaluation, use, and/or processing, and in microbiology. Students lacking adequate background to register in graduate courses at the University of Illinois are expected to remove course deficiencies during the first year of graduate study.

GRADUATE FACULTY

Professors: R. O. Nesheim (Head of Department), D. E. Becker, H. H. Draper, R. M. Forbes, U. S. Garrigus, A. H. Jensen, J. Kastelic, A. V. Nalbandov, H. W. Norton, R. F. Nystrom, B. A. Rasmusen, H. M. Scott, R. J. Webb.

Associate Professors: D. J. Bray, B. C. Breidenstein, P. J. Dziuk, E. E. Hatfield, J. M. Lewis, S. P. Mistry.

Assistant Professors: W. W. Albert, A. Bensadoun, B. G. Harmon, F. C. Hinds, R. G. Kauffman.

COURSES FOR GRADUATES

400. **Seminar.** A review of current literature in the science of animal production. ¼ unit. Prerequisite: Consent of instructor. Staff.

401. **Principles of Beef Production.** A critical study of the objectives, design, and results of beef cattle experiments. 1 unit. Prerequisite: Consent of instructor. Garrigus.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. ½ unit. Prerequisite: Consent of instructor. Garrigus.

403. **Technics and Topics in Animal Research.** Discussion and study of literature pertaining to animal research; application of experimental technics; special topics; review of research in current problem areas. ½ unit. Prerequisite: Consent of instructor. Becker.

404. **Principles of Poultry Production.** A discussion of research methods and findings in the field of poultry science, with some consideration of current industry problems. ½ unit. Prerequisite: Consent of instructor. Scott.

405. **Advanced Animal Genetics.** Genetic theory, analysis of animal breeding problems, genetic results of selection, and different systems of breeding. 1 unit. Prerequisite: Animal Science 305 or equivalent. Norton.

406. **Physiology of Reproduction.** Same as Zoology 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. Nalbandov.

407. **Laboratory Methods in Animal Genetics.** ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. Norton.

408. **Laboratory Methods in Physiology of Reproduction.** Same as Zoology 408. ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. Nalbandov.

410. **Research Methods in Animal Science.** Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. ¼ to 1 unit; may be repeated for credit not to exceed a total of one unit. Prerequisite: Consent of instructor. Becker, Breidenstein, Garrigus, Scott, Staff.

411. **Population Genetics and Animal Breeding.** Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. **Advanced Endocrinology.** Same as Dairy Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. ½ unit; may be repeated for credit not to exceed a total of two units. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

420. **Comparative Nutrition.** Physiological aspects of the nutrition of higher animals and man, including the digestion, utilization and function of nutrients, and the effects of dietary deficiencies. 1 unit. Prerequisite: Chemistry 350 and 355. FORBES, MISTRY.

421. **Topics in Nutritional Biochemistry.** Biochemical aspects of the nutrition of higher animals and man, with emphasis on the function and metabolism of nutrients. 1 unit. Prerequisite: Animal Science 420. DRAPER, MISTRY.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. CARMER.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Animal Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Animal Science 440 or equivalent. CARMER.

463. **Radioisotopes in Biological Research: Principles and Practice.** See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology and/or consent of instructor. TWARDOCK.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. CONRAD, NYSTROM.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Beef Production.** The principles of feeding and management of beef cattle; financial aspects of beef production; diseases, parasites, and breeding difficulties of beef cattle. Lectures, demonstrations, and discussions. ¾ unit. Prerequisite: Animal Science 220 or equivalent. ALBERT.

302. **Sheep Production.** The sheep and wool industries; principles and practices of various phases of production. ¾ unit. Prerequisite: Animal Science 220 or equivalent. GARRIGUS.

303. **Pork Production.** The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. ¾ unit. Prerequisite: Animal Science 220 or equivalent. BECKER, HARMON, JENSEN.

304. **Poultry Management.** Application of scientific principles to the management of poultry. Undergraduate students may register for four hours credit with laboratory or for three hours credit without laboratory. ¾ unit. Prerequisite: Animal Science 220 or equivalent. BRAY, SCOTT.

305. **Genetics and Animal Improvement.** Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. ¾

unit (Summer Session, ½ unit) . Prerequisite: Animal Science 110 or equivalent. DeFries, Rasmusen, Touchberry.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit. Prerequisite: Zoology 104 and either Dairy Science 100 or Animal Science 100. Graves.

332. **Livestock Marketing.** Same as Agricultural Economics 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip: estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. Broadbent.

ANTHROPOLOGY

The Department of Anthropology offers graduate work leading to the Master of Arts and Doctor of Philosophy. Course work is available in the main branches of cultural anthropology, including linguistics, and in physical anthropology. Special training is available in a number of world areas—South and Southeast Asia, Africa, Indonesia, Latin America, North America, Russia, and Siberia. Among the fields in which the department has specialized are: processes of culture growth and change; urban anthropology; personality and culture; political anthropology; population genetics; human ecology; ethnolinguistics; field research techniques. Investigations in American archaeology include the Southwest, the Midwest, Eastern United States, and South America, with work in the Midwest facilitated by the programs of the Illinois Archaeological Survey. Opportunities for field work in the various branches of anthropology are regularly provided. The University of Illinois is affiliated with the Museum of Northern Arizona, Flagstaff, as a cooperating institution; facilities of this museum are available to staff members and advanced students.

Applicants for admission as first-year graduate students must (1) fulfill the general requirements of the Graduate College, and (2) have a grade-point average of at least 3.75. A student who does not have an undergraduate major in anthropology or its equivalent may be permitted to register for graduate courses, but will be required to make up any deficiencies.

A detailed statement of requirements for higher degrees and additional information about departmental programs and policies is available on request.

The prerequisite for a graduate minor in anthropology is six semester hours of undergraduate credit in anthropology. A student intending to offer anthropology as a minor subject should consult with the head of the department.

GRADUATE FACULTY

Professors: J. B. Casagrande (Head of Department) , E. M. Bruner, O. Lewis, J. C. McGregor, D. B. Shimkin, J. H. Steward.

Associate Professors: D. W. Lathrap, F. K. Lehman.

Assistant Professors: A. H. Jacobs, D. G. Metzger, J. F. Yegerlehner.

Instructors: C. J. Bareis, A. H. Rohn, Jr.

COURSES FOR GRADUATES

401. **General Anthropology, I.** A comprehensive survey of the various subfields of anthropology, with special reference to contemporary trends in theory and method: anthropology among the sciences, historical perspectives, human evolution and variation, the nature of culture, cultural evolution, the ecological approach, archaeology, linguistics. 1 unit. Prerequisite: Twelve hours of anthropology or consent of instructor.

402. **General Anthropology, II.** Continuation of Anthropology 401. Cultural typology, technology and economic organization, social structure, political organization, religion, art, personality and culture, processes of culture change, acculturation, applied anthropology, the logic of anthropological research, field methods. 1 unit. Prerequisite: Anthropology 401 or consent of instructor.

429. **The Evolution of Agricultural Economies.** Same as Agronomy and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. LATHRAP, STAFF.

440. **Problems in Physical Anthropology.** A seminar designed to involve students in the theoretical and methodological approaches to problem areas in physical anthropology. 1 unit. May be repeated for additional credit. Prerequisite: Anthropology 340; consent of instructor.

450. **Seminar in Anthropology.** Analysis of selected topics of special interest in anthropology. 1 unit. Students may reregister in this course up to a total of two units. STAFF.

451. **Social Structure.** This course is intended to acquaint the student with the descriptive techniques and methods of structural and functional analysis currently employed by social anthropologists in the study of primitive social groups and their methods of operation. 1 unit. Prerequisite: Consent of instructor. STAFF.

452. **Research Problems in Archaeology.** Seminar oriented to current research problems in archaeology, designed to acquaint students with theoretical and methodological aspects of particular problems, and to develop a critical perspective of archaeological research. Course may be repeated for additional credit. 1 unit. Prerequisite: Consent of instructor. MCGREGOR.

453. **The Formal Analysis of Kinship Systems.** A survey of a variety of the world's systems of kinship, marriage, and family organization. Concentration on the distinctive properties of kinship systems as a species of social structure, on the formal apparatus for describing and understanding them and their functions, and on the theory of kinship that arises from the use of such formal apparatus. ½ or 1 unit. Prerequisite: Consent of instructor. LEHMAN.

460. **Theories and Methods in Anthropology.** A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. 1 unit. CASAGRANDE.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. 1 unit. Prerequisite: Consent of instructor. STEWARD.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. 1 unit. Prerequisite: Anthropology 461 or consent of instructor. STEWARD.

463. **Seminar on Field Methods and Research Designs in Cultural Anthropology.** Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and comparative studies on both the tribal and peasant levels are examined. 1 unit. Prerequisite: Consent of instructor. STAFF.

471. **Personality, Culture, and Society.** A seminar on selected topics in culture and personality. The emphasis varies from year to year; possible topics include the interrelationship between social systems and personality, national character studies, comparative education, cultural learning and transmission, the psychological concomitants of cultural change. 1 unit. Prerequisite: Consent of instructor. BRUNER.

489. **Readings in Anthropology.** Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interests of the student. ½ or 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. STAFF.

490. **Individual Topics in Anthropology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study are approved by the adviser and the staff member who supervises the work. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** Preparation of theses. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** Same as Linguistics 300. An introduction to the science of descriptive linguistics. ½ or 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

309. **Field Methods in Linguistics.** Same as Linguistics 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. LEHMAN, YEGERLEHNER.

310. **Advanced Field Methods in Linguistics.** Same as Linguistics 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Anthropology 309 or equivalent. LEHMAN, YEGERLEHNER.

315. **Area Studies in Ethnomusicology.** Same as Music 317. A seminar devoted to intensive study in the music of one specific culture, e.g. (a) Japan, (b) China, (c) Indonesia, (d) India, (e) the Near East, (f) African and New World Negro, (g) European and American folk cultures, (h) American Indian. ½ unit. Prerequisite: Senior standing in music or consent of instructor. NETTL.

316. **Introduction to Music of the World's Cultures.** Same as Music 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. **Languages of the World.** Same as Linguistics 317. A survey of the main language families of the world from both genetic and typological points of view. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

320. **Political Anthropology.** The comparative and analytic study of the political systems of representative non-Western peoples. Attention is also paid to the transformations of native political institutions as consequences of colonialism and political modernization. ½ or 1 unit. Prerequisite: Anthropology 103. JACOBS.

330. **Processes of Culture Change.** The impact of modern cultures on native peoples, comparative study of the mechanisms underlying the transition to modernity in the new nations, and the psychologican and structural aspects of acculturation and urbanization. ½ or 1 unit. Prerequisite: Anthropology 103 or consent of instructor. BRUNER.

331. **Aboriginal North America.** The course will deal with three major topics: (1) the nature and structure of aboriginal North America as a cultural province and its ecological base; (2) distinctive and common features of American Indian cultures; (3) responses to the stresses of white contact. Selected type cultures and their adaptations to varying ecological situations are examined in detail. A student may not receive credit for both Anthropology 270 and 331. ½ or 1 unit. Prerequisite: Anthropology 260. SHIMKIN.

332. **Native Cultures of South America.** A survey of the nature and variability of the aboriginal Indian cultures of South America. Special emphasis is placed on the relationship between various typical cultures and their ecological setting. Sample cultures illustrating the full range of community stability, population density, and social complexity are studied. ½ or 1 unit. Prerequisite: Anthropology 260 or consent of instructor. STAFF.

340. **Human Evolution, I.** The principles of evolution, and a survey of the evolution of man and his progenitors to the Paleolithic. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

341. **Human Evolution, II.** The principles of human genetics, anthropological aspects of race and race formation, and hereditary and environmental factors in the biological variation of modern man. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

343. **Introduction to Primate Morphology and Behavior.** A survey of primate social behavior and the classification, morphology, and distribution of living and extinct species. Emphasis is placed on interrelationships with aspects of anthropological study. ½ or 1 unit. Prerequisite: Anthropology 340, or Zoology 101 or 104, or consent of instructor.

350. **Archaeology of South America.** This course studies the peopling of the continent and the subsequent rise of agricultural economies. Emphasis is placed on the spectacular rise of civilization in the region of the Central Andes. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. LATHRAP.

351. **Archaeological Surveying: Techniques and Applications.** Familiarization with methods used in the location and recording of archaeological sites, including techniques of mapping especially adapted to the needs of archaeology. Attention is also given to means of presenting results and interpreting data derived from this work. The course involves work both in the field and in the laboratory. 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. STAFF.

352. **Precolumbian Civilizations of Mesoamerica.** The major civilizations of Mexico and Guatemala are studied. Emphasis is placed on the growth and ramification of the several major cultural traditions and on the kinds of evidence which are available as a basis for the study of the growth of political units and their interaction. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. LATHRAP.

353. **Southwestern Archaeology.** A detailed study of one archaeological unit in the United States, covering the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MCGREGOR, ROHN.

354. **Field Techniques in Archaeology.** Participation in archaeological excavation; techniques, methods, and procedures discussed and practiced in actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

355. **Laboratory Techniques and Problems in Archaeology.** Laboratory work in the field; studying, evaluating, and writing final reports on preceding field work. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

356. **Physical Anthropology.** The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, physiology, or introductory zoology. MCGREGOR.

357. **Midwestern Prehistory.** A detailed study of the midwestern archaeological area covering the broad cultures with regional variations considered chronologically and stressing their interrelationships. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. McGregor.

360. **Peoples of Oceania.** A survey of the groups inhabiting the islands of the Pacific, including Australia. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

361. **Peoples and Cultures of Mexico and Guatemala.** A survey of the people and cultures of Middle America with special emphasis upon Mexico and Guatemala. This course begins by placing Middle America geographically, historically, and culturally within the broader Latin American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Lewis.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from archaeological and historical records as well as from contemporary ethnological studies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. Staff.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. Staff.

366. **Peoples of Southeast Asia and Indonesia.** The culture, history, economy, social system, political organization, and character structure of the peoples of Indonesia, Malaya, and the Philippines. Attention also is paid to contemporary economic and political problems of the newly independent nations seen from an anthropological perspective. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Bruner, Lehman.

367. **Peoples and Cultures of Africa.** A survey of the cultures of Africa with particular emphasis on the ecological and historical development of culture types and the behavior associated with them. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Jacobs.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

369. **Introduction to Human Ecology.** Same as Geography, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit.

Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Language, Culture, and Society.** Same as Communications and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

371. **Culture and Personality.** A cross-cultural comparative analysis and evaluation of current theories of culture and personality formation. The course is concerned with the socio-cultural matrix in which personality develops, as well as with the application of personality concepts, especially those derived from psychoanalytic theory, to the study of primitive and modern society. ½ or 1 unit. Prerequisite: An introductory course in anthropology, sociology, or psychology, or consent of instructor. BRUNER.

372. **The Anthropological Study of Art.** A review of the anthropological approach to art with emphasis on structural analysis and the relationship of the artist to his culture. Problems of stylistic development are considered within the framework of cultural dynamics, and a survey of the major art style areas outside the Western tradition and the Orient is included. ½ or 1 unit. Prerequisite: Three hours of anthropology or consent of instructor. LATHRAP.

373. **Human Development in Cross-Cultural Perspective.** Same as Psychology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, sociology, or psychology, or consent of instructor.

374. **Problems in Human Ecology.** Same as Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. JACOBS, STAFF.

375. **Peoples and Cultures of the Near and Middle East.** A general survey of the bionomy of the area, followed by a description and analysis of the cultural patterns and social systems of the major ethnolinguistic divisions—Semitic, Iranian, Turkic—and the interrelating function of Islam. Particular consideration given to language, folklore, belles-lettres, music, architecture, crafts, etc., from an anthropological standpoint. Thereafter, selected ethnographies are considered for comparative purposes. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

380. **Applied Anthropology.** The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in nonindustrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

381. **Russian Culture History and Ethnology.** Same as Geography 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. **Siberian Culture History and Ethnology.** Same as Geography 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural and urban design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles); advanced structural theory and design; building construction; history of architecture.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture is 3.75. Applicants with averages below 3.75 but above 3.5 are considered on an individual basis. All applications for admission should be accompanied by samples of the applicant's work in structures and design.

Students are expected to follow one of the recommended area programs unless approval is obtained from the chairman of the department for a special program. A minimum of eight units is required for the master's degree.

GRADUATE FACULTY

Professors: J. S. Baker, L. J. Brightbill, E. A. Connally, P. H. Coy, G. Guevrekian, H. L. Hornbeak, R. A. Jones, A. K. Laing, D. B. Lindsay, R. P. Link, C. B. Looker, E. I. Love, J. G. Replinger, I. Schousboe, R. J. Smith, J. H. Swing, S. J. Y. Tang, E. F. Toth, A. R. Williams.

Associate Professors: G. T. Clayton, E. M. Farnham, H. C. Young.

COURSES FOR GRADUATES

417. **Development of Contemporary Architectural Thought.** An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, Mies van der Rohe, Viollet-le-Duc, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, Serlio, and Vitruvius. ½ unit. Prerequisite: Consent of instructor. Laing.

431. **Advanced Theory of Architecture.** A review of principles of architecture and urban design; factors in programming architectural requirements; design development; analysis and criticism. ½ unit. Prerequisite: Consent of instructor. Williams.

432. **Seminar in Architectural Design.** The analysis and criticism of selected buildings. Individual reports and discussion. ½ unit. Prerequisite: Architecture 431 or consent of instructor. Williams.

435. **Advanced Architectural Design.** Advanced study of space relationships and other elements of architectural design from urban scale to that of individual buildings, including the integration of structural, mechanical, and interior design. Joint studies in urban design with graduate students in urban planning and landscape architecture. 2 units. Prerequisite: Bachelor's degree in architecture (general option) or consent of instructor. Williams.

452. **Advanced Theory and Design of Steel Structures.** Theory and design in bending, buckling, torsion, and combined stresses in beams and columns. Study in design and behavior of connections; composite constructions; light gage steel construction analysis. Design and economy of simple and complex building frames. 1 unit. Prerequisite: Architecture 348 or consent of instructor. Schousboe, Tang.

454. **Advanced Structural Design in Reinforced Concrete.** Critical review of the methods and specifications involved in the design and behavior for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way and flat-slab floor construction; columns and footings; torsion; ultimate theory of design; economy and continuity in building design. 1 unit. Prerequisite: Architecture 358 or consent of instructor. Tang.

481. **Advanced Building Construction.** Characteristics and relationships of the multiple components of the building industry: labor, general and specialty contracting, the manufacture and distribution of materials, finance, government, building ownership and operation. Building costs and cost analysis. Studies of selected building materials, products, and construction techniques. ½ unit. Prerequisite: Consent of instructor. CLAYTON.

491. **Special Problems in Building Construction.** Individual direction in the investigation of selected topics in building construction. ½ to 2 units. Prerequisite: Credit or registration in Architecture 481. CLAYTON.

493. **Special Problems in Structural Theory and Design.** Individual or group investigation and study in architectural engineering application. Research in economy and design in correlation with architectural, mechanical, and structural requirements. Options: foundation design; prestressed concrete design; plastic design in steel; structural planning; wood construction; architectural research laboratory. ½ to 4 units. Prerequisite: Consent of instructor. HORNBEAK, SCHOUSBOE, TANG, STAFF.

494. **Special Problems in Architectural Design.** Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. ½ to 2 units. Prerequisite: Architecture 435 or consent of instructor. WILLIAMS, VISITING CRITICS.

496. **Special Problems in Architectural History.** Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. ½ to 2 units. Prerequisite: Architecture 417 or consent of instructor. CONNALLY, LAING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Architectural Design.** Continued study of architectural design emphasizing (a) complex site development and composition, and (b) definitive design and refinement of detail for one of the plan components. Preparation of senior thesis program. 2 units. Prerequisite: Architecture 236. STAFF.

338. **Architectural Design.** Individual research and comprehensive design solution of a selected architectural project, with special emphasis on site development, integration of structures; mechanical equipment, illumination, and acoustics. 2 units. Prerequisite: Architecture 337. STAFF.

339. **Urban Housing.** Study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. ½ unit. Prerequisite: Consent of instructor. JONES.

347. **Theory of Structures.** Advanced problems in the analysis of statically determinate structures; general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. 1½ units. Prerequisite: Architecture 257; Mathematics 142. HORNBEAK.

348. **Advanced Structures.** Advanced topics on design of structural members and connection. Analysis and design of continuous structures, rigid frames, and tall buildings. 1½ units. Prerequisite: Architecture 347; credit or registration in Architecture 358. COY.

358. **Advanced Reinforced Concrete.** Reinforced concrete building design. 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348. TANG.

ART

The Department of Art offers graduate work leading to the degrees listed below. For admission, an applicant must be a graduate of an accredited college or university with at least a bachelor's degree and with a grade-point average of 3.5 or above; he must be accepted by the graduate committee of the Department of Art after

examination of his transcripts, as well as examples of his work if his major is to be in a creative field. Students expecting to major in art education must have (or be eligible for) a teaching certificate in their field. Applicants are expected to have completed an undergraduate program similar to that which leads to the bachelor's degree as established at this University, with a major, or related studies acceptable to the advisers, in the field to be pursued in graduate study.

Normal residence requirement is two years for the Master of Fine Arts and one year for the Master of Arts, although the graduate committee may extend this requirement or increase the unit requirements if this seems warranted.

Complete descriptions of offerings and admission requirements for all degrees and instructions for applying for admission and grants may be had by writing for application forms and the brochure on Graduate Programs in Art, to Warren F. Doolittle, Chairman of Graduate Programs in Art, Department of Art, 140 Fine and Applied Arts Building.

Master of Fine Arts with Design Major (Graphic Design or Industrial Design). Students must complete all the following courses for a minimum of twelve units: Art 491, two to four units; Art 493, one unit; Art 467 or 477, four to six units; art history (selected from the group Art 306 through 328), three-fourths unit to one and one-half units; electives or interdisciplinary subjects as determined in consultation with the adviser, two to four units. A thesis is required. Students majoring in graphic design who hold one-half time teaching or research assistantships may expect correspondingly extended residence due to reduced academic load.

Master of Fine Arts with Painting and Printmaking Major. Students must complete all the following courses for a minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 495, two to five units; Art 497, two to five units, one unit of which must be in intaglio; art history (two courses selected from the group Art 306 through 328), one and one-half units; electives (Art 332, 341, 351, 392, 393, 394, 491, 494; art history and/or other courses approved by the adviser), one and one-half to two and one-half units. A thesis is required.

Master of Fine Arts with Sculpture Major. Students must complete all the following courses for a minimum of twelve units: Art 491, one to three units; Art 493, one unit; Art 496, four to six units; art history (two courses selected from the group Art 306 through 328), one and one-half units; electives (Art 332, 333, 341, 383, 392, 393, 394, 491, 494; art history and/or academic courses approved by the adviser), one to three units. A thesis is required.

Master of Arts with Art Education Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; art history (one course selected from the group Art 306 through 328), three-fourths unit; art electives, two and one-fourth units; Educational Psychology 311, one-half unit; Educational Psychology 312, one-half unit; Secondary and Continuing Education 456, one unit; two of the following: History and Philosophy of Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required.

Master of Arts with Art History Major. Students must complete all the following courses for a minimum of eight units: Art 341, one-half unit; Art 491, one to three units; Art 493, one unit; Art 494, one unit; art history (courses selected from the group Art 306 through 328), one and one-half to three units; electives, one or two units. A thesis is required. A reading knowledge of a foreign language is a requirement for the degree.

Doctor of Education in Art Education. The program leading to the Doctor of Education with a major in art education is designed to provide advanced professional preparation for art educators and to develop educational leaders with a high level of art and educational competence. The program is offered jointly by the Department of Art and the College of Education.

Admission. A candidate for admission must hold a master's degree in fine arts, or art education, or the equivalent from an accredited institution. He must also have a minimum of two years' acceptable teaching experience. Admission is determined by examinations administered by the Department of Art and the College of Education, personal interviews, record of previous education and experience, and recommendations from persons who have known the candidate. Examinations administered by the Department of Art include art education, art history, and art processes. Portfolios of art work may also be required.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the Department of Art and one from the College of Education.

Residence. Minimum residence requirement is one year of uninterrupted work during which a minimum of six units of work is successfully completed. The remaining course work may be completed during summer sessions or during the regular school year.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in art and art education and six units of credit in education. The following courses are required: Elementary Education 455, one unit; History and Philosophy of Education 405 and 410, two units; Educational Psychology 390 and 415, two units; Art 493, one unit; a course in research in Art Education, one unit; electives in art and art education, three units; electives in education, two units; electives, four units.

A thesis is required, but no academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of the thesis title and the preparation, submission, and publication of the thesis must be met.

GRADUATE FACULTY

Professors: J. R. Shipley (Head of Department), E. H. Betts, C. W. Briggs, L. R. Chesney, Jr., C. A. Dietemann, W. F. Doolittle, D. E. Frith, J. D. Hogan, J. W. Kennedy, K. M. Lansing, R. Perlman, E. C. Rae, F. Roos, H. A. Schultz, M. A. Sprague, R. A. von Neumann, A. S. Weller, E. J. Zagorski, N. Ziroli.

Associate Professors: Ann Perkins, A. R. Sinsabaugh, R. W. Sterkel, E. C. Wicks.

Assistant Professors: P. Bodnar, N. McFarland, Minerva Pinnell, R. A. Smith, M. Tischler.

Instructor: M. Franciscono.

COURSES FOR GRADUATES

450. **Studies in Modern Art.** Investigation of special problems; writings of artists and critics; preparation of critical reports. 1 unit. Prerequisite: Consent of instructor.

451. **Studies in American Art.** Investigation of special problems; historical development of the study of American art; techniques of conservation and restoration. 1 unit. Prerequisite: Consent of instructor.

467. **Graphic Design Laboratory.** Individually directed research in problems of visual design with emphasis on the understanding of recent developments in nonverbal communication and the utilization of contemporary graphic processes. 1 to 2 units. Prerequisite: Bachelor of Arts or Bachelor of Fine Arts in visual communications area or related equivalent. Staff.

477. **Industrial Design Laboratory.** Individually directed research in the drafting room or workshop with concentration in industrial design. 1 to 2 units. Prerequisite: Bachelor of Fine Arts in industrial design or equivalent. Staff.

491. **Special Problems.** Individual direction in research and in creative activity; thesis. ½ to 2 units. STAFF.

493. **Seminar.** Introduction to methods and criticism. 1 unit. ROOS.

494. **Studies in Art History and Criticism.** Individual study of special periods of art history; intensive reading of selected critical works; the writing of art criticism. 1 unit. Prerequisite: Graduate standing in art; graduate standing in other departments with consent of departmental graduate committee. RAE, ROOS, WELLER.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. ½ to 2 units. STAFF.

496. **Sculpture Laboratory.** Experience at a professional level in sculptural techniques including metals casting, welding, stone carving, wood carving, clay modeling, and ceramic sculpture, with emphasis on the development of creative achievement. 1 to 3 units. Prerequisite: Graduate standing in art and permission of the departmental graduate committee.

497. **Print Workshop.** Intaglio, relief, and planographic; printing, including etching, engraving, aquatint, wood, paper and plastic relief printing, and lithography. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Near Eastern and Greek Art.** Architecture, sculpture, and painting of Egypt, Western Asia, Crete, and of Greece from Mycenean times through the Classical period. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

307. **Hellenistic, Roman, and Byzantine Art.** Architecture, sculpture, painting, and mosaics of the Hellenistic world, Italy and the Roman empire, and the Byzantine empire. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

308. **Early Medieval Art.** The arts of Byzantium and of Western Europe from the early Christian through the Romanesque period. ¾ unit. Prerequisite: One year of history of art.

309. **Gothic Art.** The arts of Western Europe from the end of the Romanesque period until the Renaissance. ¾ unit. Prerequisite: One year of history of art.

310. **The History of Printmaking.** The development of the various graphic processes in the hands of important printmakers from the fifteenth through the nineteenth centuries. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

318. **Latin American Art.** Study of the more important phases and periods of the visual arts of Latin America. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

319. **Italian Art of the Seventeenth and Eighteenth Centuries.** An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

320. **Northern European Art of the Seventeenth and Eighteenth Centuries.** An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, and England during the seventeenth and eighteenth centuries, in terms of major figures and dominant stylistic developments. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

321. **Twentieth-Century Art: 1900-1925.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

322. **Twentieth-Century Art: 1925 to Date.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

323. **American Art to 1840.** Architecture, painting, sculpture, and minor arts of the Colonies and the United States to 1840. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

324. **American Art, 1840 to 1900.** Architecture, painting, sculpture, and minor arts of the United States. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

325. **Recent American Painting and Sculpture.** Current developments, with special emphasis on works shown in contemporary exhibitions at the Krannert Art Museum. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

327. **Japanese Art.** History of Japanese art from earliest times to the twentieth century. ¾ unit. Prerequisite: One year of history of art or junior standing.

328. **Chinese Art.** History of Chinese art from earliest times to the present. ¾ unit. Prerequisite: One year of history of art or junior standing.

332. **Drawing.** Advanced drawing in several media. ½ to 1 unit. Prerequisite: Art 126 or equivalent; for graduate students, consent of departmental graduate committee. STAFF.

333. **Painting.** Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts in painting and printmaking. ½ to 1 unit; may be repeated for a total of two units. Prerequisite: Art 142 or equivalent; for graduate students, consent of departmental graduate committee. STAFF.

341. **Painting Materials and Techniques.** Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. ½ unit. Prerequisite: Art 142 or graduate standing in art.

351. **Advanced Sculpture Techniques.** Advanced work in various sculptural media. ½ to 1 unit. Prerequisite: Art 252 or equivalent.

383. **Print Media.** Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts in painting. ½ to 1 unit. Prerequisite: Art 284 or equivalent; for graduate students, consent of departmental graduate committee.

385. **Lithography.** Laboratory course in lithography. Course of study includes a complete development of the process, exploiting its potential as a fine art medium. ½ to 1 unit. Prerequisite: Art 286; for graduate students, consent of departmental graduate committee.

392. **Silversmithing, I.** Advanced course in design and execution of hollow ware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. ½ to 1 unit. Prerequisite: Consent of instructor.

393. **Silversmithing, II.** Advanced course in design and execution of flatware and hollow ware, dealing primarily with forging and seaming methods, engraving, and toolmaking. ½ to 1 unit. Prerequisite: Consent of instructor.

394. **Ceramic Design.** Ceramic design with emphasis on the development of professional style and personal expression. ½ to 2 units. Prerequisite: Art 295 or consent of instructor.

ASIAN STUDIES

A graduate minor in Asian studies is administered by the Center for Asian Studies in cooperation with various departments. It is possible for a graduate student electing this minor to concentrate on East Asia, Southeast Asia, South Asia, or the Near and Middle East, or a combination of two or more of these areas.

A candidate for a master's degree who elects Asian studies as a minor must earn at least two units of graduate credit in at least two departments from the courses listed below.

A doctoral candidate who elects Asian studies as a minor must earn at least four units of graduate credit in at least two departments from the following courses: Art 327, 328; Agricultural Economics 401; Agronomy 429; Anthropology 315, 316, 366, 368, 375, 382, 429, 461, 462; Arabic 303, 304; Burmese 303, 304; Chinese 303, 304; Economics 312, 353, 358, 409, 410, 411; Geography 351, 357, 369, 382, 429, 495; Hindi 303, 304; History 307, 308, 374, 387, 388, 389, 391, 392, 393, 394, 395, 396; Indonesian 303, 304; Japanese 303, 304; Linguistics 303, 350, 490; Music 316, 317; Philosophy 361; Political Science 337, 338, 347, 348, 349, 380, 441, 447; Rural Sociology 477; Sociology 326, 343, 370, 371, 418, 477; Speech 468.

Also, the doctoral candidate must, prior to the completion of his course requirements for the degree, complete satisfactorily one of the following: Arabic 304, Burmese 304, Chinese 304, Hindi 304, Indonesian 304, Japanese 304, or equivalent.

Candidates should contact the Director of the Center for Asian Studies regarding additional courses which would be acceptable.

Students who do not elect an Asian studies minor but who seek knowledge of Asian affairs, cultures, and languages are invited to consult, either directly or through their advisers, with the Director of the Center or with faculty associated with the Center in order to develop programs suited to their individual needs.

The adviser for the graduate minor is Professor Solomon B. Levine, Director of the Center for Asian Studies, 1207 West Oregon Street, Urbana 61801.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Astronomy (including radio astronomy). Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. In addition, the normal entrance requirements are as follows: (1) a bachelor's degree in astronomy, physics, electrical engineering, or mathematics, and (2) a one-year course in descriptive astronomy.

The eight units for the Master of Science may be obtained in three ways, listed as (1), (2), and (3) below. Alternative (3) is intended for students wishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be at the 400 level.

(2) Two units may be selected from approved courses in mathematics; two units may be taken in approved courses in physics; the remaining units must be taken in astronomy. At least three units must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be secured by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the Doctor of Philosophy may be obtained by writing to the Head of the Department, University of Illinois Observatory.

For information regarding applied mathematics, see page 253.

GRADUATE FACULTY

Professors: G. C. McVittie (Head of Department), G. W. Swenson, Jr., S. P. Wyatt, Jr., K. M. Yoss.

Assistant Professors: J. R. Dickel, J. B. Kaler.

COURSES FOR GRADUATES

401. **Stellar Atmospheres.** Physical characteristics of stellar atmospheres as derived from spectroscopic observations; radiation transfer, theory and observations of the continuous spectrum, limb darkening; formation of absorption lines, line profiles, curves of growth, relative chemical abundances; emission features; forbidden radiation. 1 unit. Prerequisite: Consent of instructor. Kaler.

403. **Gaseous Nebulae and the Interstellar Medium.** Distribution, structure, and spectra of nebulae; physical processes in planetary and diffuse nebulae; recombination, fluorescence, and forbidden line radiation; determination of physical parameters; nature of the interstellar medium; interstellar gas and grains; observation of interstellar medium. 1 unit. Prerequisite: Astronomy 301. Kaler.

404. **Theory of Stellar Structure.** Masses, luminosities, radii, and surface temperatures of stars; basic equations and stability conditions; nuclear reactions; integration of basic equations; results—initial stages, later stages, white dwarfs. 1 unit. Prerequisite: Consent of instructor. Olson.

415. **Experimental Methods in Radio Astronomy.** Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. 1 unit; may be taken a second time for credit. Prerequisite: Consent of instructor. Dickel, Swenson.

424. **Relativity and Cosmology.** Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

433. **Solar System Astrophysics.** Planetary orbits and perturbations; physical perturbations; physical parameters of the planets; planetary interiors, atmospheres, magnetospheres, and surface layers. The satellites. Asteroids and comets. Meteors, meteorites, and tektites. Interplanetary grains and gas. Problems of origin and evolution. 1 unit. Prerequisite: Consent of instructor. Dickel, Wyatt.

486. **Constitution of the Ionosphere: An Introduction to Aeronomy.** Same as Electrical Engineering 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent. Bowhill.

491. **Seminar in Special Topics.** 1 to 4 units. Prerequisite: Consent of instructor. Staff.

499. **Thesis Research.** 0 to 3 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introductory Astrophysics.** Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors; special types of stars, interstellar matter. 1 unit. Prerequisite: Physics 108. Kaler.

302. **Astrophysics of the Sun.** Observations of the sun at all wave lengths and application of the results to the study of the photosphere, chromosphere, and corona; structure of the atmosphere of the quiet sun; solar activity. 1 unit. Prerequisite: Astronomy 301. Dickel.

306. **Foundations of Mechanics and Gravitational Theory.** Same as Aeronautical and Astronautical Engineering 306. Introduction to the dynamics of particles and of

rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. McVittie.

307. **Celestial Mechanics.** Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. 1 unit. Prerequisite: Astronomy 306 or Physics 322. McVittie.

314. **Observational Astronomy.** Same as Civil Engineering 305. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143. Wyatt.

315. **Observational Techniques and Reductions.** Methods of observation and reductions in photographic and photoelectric photometry, spectrophotometry, and stellar radial velocity determinations. 1 unit. Prerequisite: Astronomy 314. Yoss.

321. **Stellar Systems, I.** Galactic structure: the observational data, stars in the solar neighborhood, the solar motion, stellar statistics and distribution, stellar populations, interstellar matter and spiral structure, the whole galaxy. 1 unit. Prerequisite: Astronomy 102 or 210; Physics 108. Yoss.

322. **Stellar Systems, II.** Continuation of Astronomy 321. Galactic dynamics: stellar motions, galactic rotation, dynamics and mass distribution, stellar encounters, dynamics of interstellar matter. Galaxies: distances, structural features, groups and clusters, radio galaxies and quasars, spatial distribution and motions. 1 unit. Prerequisite: Astronomy 321. Wyatt.

357. **Radio Astronomy.** Same as Electrical 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108. Dickel.

366. **Aeronomy: Physics of the Upper Atmosphere and Space.** Same as Electrical Engineering and Physics 366. Structure and composition of the earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321, and 381; or consent of instructor. Bowhill, Raether.

BIOCHEMISTRY

Biochemistry is a multidisciplinary field resulting from an interaction of chemistry and physics with biology. The biochemistry staff offers training in biochemistry, or molecular biology and biophysical chemistry (see pages 81 and 92). Programs leading to graduate degrees in biochemistry are offered in the Biochemistry Division of the Department of Chemistry and Chemical Engineering. Entering graduate students in biochemistry must therefore meet the graduate entrance requirements of that department (see page 91).

Interested students should contact the Biochemistry Division.

BIOLOGY

See descriptions and course listings under Life Sciences, page 215.

BIOPHYSICS AND BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

Biophysics is a rapidly growing field that cuts across many disciplines. An area overlapping with this and developing through interaction of chemistry and biology is that of biophysical chemistry.

Since graduate study in biophysics and biophysical chemistry involves several areas of biological and physical science, the Graduate College has adopted a flexible system enabling students to enter special interdisciplinary programs in these areas, thus affording them a wide range of opportunity for study and research in borderlands between the biological and physical sciences.

For the program leading to the Doctor of Philosophy in Biophysics, see descriptions and course listings under Life Sciences, pages 227 and 231.

Students majoring in chemistry or microbiology may elect to specialize in biological problems at the molecular level (see pages 92 and 224). Students in other areas of the biological and physical sciences who wish to arrange programs of study emphasizing biophysics should direct their inquiries to the head of the major department.

BOTANY

See descriptions and course listings under Life Sciences, page 217.

BUSINESS

The Doctor of Philosophy in Business is awarded to those who complete the subject matter requirements listed below and the general requirements outlined in the first section of this catalog. The subject matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by synchronization of courses previously taken with those offered in this program.

In lieu of the usual major and minor requirements for the doctorate, candidates for the Doctor of Philosophy in Business must prepare themselves for examination in five fields. Two of these, management and economic theory, are required, but the other three are elective. One of the elective fields may be outside the College of Commerce and Business Administration and must include at least two units. Within these requirements it is expected that each student will select, in consultation with his adviser, an individual program of study to meet his specific needs and objectives. For numbers and titles of courses available, see the listings in this catalog under accountancy, business education, economics, finance, industrial administration, and marketing.

Because the major fields for this degree cross departmental lines, administration of the work is supervised by a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the Chairman of the Committee on the Doctor of Philosophy Degree in Business, 360 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

499. Thesis Research. 0 to 4 units.

BUSINESS ADMINISTRATION

The Graduate School of Business Administration offers professional programs in business administration leading to the degrees of Master of Business Administration, Doctor of Business Administration, Master of Accounting Science, and Master of Commerce.

Master of Business Administration. The Master of Business Administration program is designed primarily for students whose undergraduate preparation is in liberal arts and sciences, engineering, or other nonbusiness areas. Students whose undergraduate preparation is in business may apply for admission, and the make-up of programs of those admitted is frequently adjusted to account for the special preparation of the degree candidate. The M.B.A. program requires a minimum of sixteen units (or sixty-four semester hours) of course work. No thesis is required. Candidates are admitted in September and February.

Doctor of Business Administration. Applicants for the Doctor of Business Administration program should have completed their master's program in the upper one-half of their master's class. A minimum of eight units of professional courses beyond the master's degree is required. Candidates who have earned a master's degree from one-year programs are required to complete a minimum of sixteen units of course work. Candidates are admitted in September, February, and June.

Master of Commerce. The Master of Commerce program is designed specifically for students whose undergraduate preparation is in business. Candidates for the Master of Commerce degree are required to take an evaluation examination upon entering the program. This examination covers the equivalent of the first-year M.B.A. program. An outstanding performance on this examination permits granting of the Master of Commerce degree after completion of eight units of course work. Normally, a candidate who is well prepared in the several areas of business administration is required to complete twelve to fourteen units of work.

Master of Accounting Science. For details of this program, see Accountancy, page 46.

Additional information concerning the requirements of the various degree programs may be obtained from the Graduate School of Business Administration, 320 Commerce and Business Administration Building (West).

PROFESSIONAL COURSES

500. **Business Economics.** Analysis of supply and demand functions in an uncertain environment; practical applications of economics to the management of business enterprise; the firm's place in the economic system; the place of the enterprise in national accounts. Case materials are used. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

501. **Managerial Economics.** Monetary and national income analyses essential to understanding governmental policies directed to macro-economic goals; the impact of such policies on the individual business firm and on decision-making by business management; the responsibilities of the individual business firms in contributing to the attainment of social goals of a macro-economic nature; the role of the business leader in formulating public policy in the macro-economic area. ¾ unit. Prerequisite: Business Administration 500 or equivalent.

510. **Administrative Behavior.** This course focuses on the problems faced by an administrator in an interpersonal setting. Primary emphasis is on the analysis of individual and group behavior in a union and nonunion work setting and the determination of actions which the administrator can take to promote desired work performance. Extensive use is made of theory and research related to individual and group behavior to aid in the diagnosis of problems covered. Students take part in either laboratory or field studies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

511. **Business Organization.** An analysis of business organization. Major emphasis is on the processes of allocation, coordination, and communication, making decisions about organizations under conditions of certainty and uncertainty for optimal performance, and measures of organizational performance. Critical examination of factors involved in choosing either a centralized or a decentralized style of organization. ¾ unit. Prerequisite: Business Administration 510.

512. **Business Organization and Its Environment.** An analysis of business organizations adapting to shifts in internal and external elements. Major emphasis is on (1) the business firm as a part of a complex socio-economic system: (2) the effects of government, labor unions, and political, religious, and business organizations on the executive's decision problems; (3) environmental factors conducive to organizational change; and (4) organizational growth. ¾ unit. Prerequisite: Business Administration 511.

513. **Seminar in Organization Theory.** This course examines the major types of organization theory. Use of organization theory to guide research and to make business decisions; examination of major research methods used to study business organizations. ¾ unit. Prerequisite: Business Administration 512.

520. **Marketing.** An introductory analysis of the marketing system, its operations, and the mechanisms for coordinating these operations. The relationships of the firm to other firms and other institutions in the marketing system are studied, and the effects that such relationships have on the nature of decision problems of the individual business are analyzed. The firm's problem in developing an integrated marketing program, and the specific problem areas of price, channel, location, sales, and market development are discussed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

522. **Quantitative Analysis for Marketing Decisions.** The development of analytic quantitative models of various aspects of the firm's marketing environment and of models of marketing decision problems is studied. The course also involves a study of the ways in which such models can be used as a basis for making marketing decisions. Topics include market measurement, estimation of various kinds of market data, identification of the relationships between marketing variables, and forecasting. ¾ unit. Prerequisite: Business Administration 520 or equivalent.

524. **Market Development.** Communication from manufacturers and middlemen to consumer and industrial users, and from manufacturers to middlemen, is an essential element in the marketing process. The course deals with management of the several components of the market communication function including personal selling, advertising, sales promotion, and some marketing aspects of public relations activities for both consumer and industrial goods. Management of the market communication function is studied through cases dealing with (1) determining market communications goals and policies; (2) creating an organization to perform the market communication function; (3) planning market communication operations, including problems such as planning a sales campaign, selecting advertising media, setting standards and coordinating advertising with personal selling, and dealer promotions; (4) stimulating personnel and controlling execution of the plans; and (5) evaluating results obtained from specific selling activities. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

525. **Product Management.** This course deals with the decisions on the firm's total market offer, including such topics as (1) use of market analysis in making decisions on assortment, product development, pricing, packaging, branding, and sales forecasting, and (2) coordination of these decisions and actions with market communications, physical movement, production, finance, and the over-all goals and policies of the firm. The use of analytic and research methods in making assortment and product decisions is emphasized. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

527. **Seminar in Marketing Theory and Policy.** This seminar is designed to study theories relating to the marketing system and the role of the individual business firm within that system. Marketing policy problems are discussed within the framework of various aspects of the firm's environmental circumstances. Marketing planning and decision-making processes covered include those involved in choice of policy concerning the marketing mix, price and product strategy, market development, and social and governmental relations. ¾ unit. Prerequisite: Business Administration 524 or 525.

531. **Introduction to Production.** An introductory course in decision-making problems in production. The course includes the theoretical foundations for production management as well as the applications of decision-making techniques to production problems in the firm. In particular, production processes, plant layout, maintenance, scheduling, quality control, and production control are considered. ¾ unit. Prerequisite: First semester of the M.B.A. program.

532. **Production Planning and Control.** Decision-making topics in production at the factory manager level and above are treated in depth. Topics include the development of generalized decision rules and systems analysis in production. In particular, the design of production control, quality control, and inventory control systems are stressed, and each of these systems is integrated into the firms as a whole. ¾ unit. Prerequisite: First year of the M.B.A. program.

533. **Quantitative Techniques in Production.** An advanced course in the application of quantitative techniques to decision-making problems dealing with production in the firm. Topics include structural estimation of production systems, application of operations research techniques to production problems, and computer simulation of decision systems. ¾ unit. Prerequisite: Business Administration 532 or equivalent.

540. **Written Analysis, I.** To develop the student's ability in writing reports based upon analysis of cases and the conclusions reached, this course has a threefold objective: (1) to improve the student's capacity to express himself effectively and efficiently in writing; (2) to contribute to the sharpening of his analytic skills; and (3) to help him integrate the knowledge learned in the functional fields. ½ unit. Prerequisite: Registration in the Graduate School of Business Administration.

541. **Written Analysis, II.** The first part of this course is devoted to the scientific method of inquiry and specific research techniques. The purpose is to study both elements of basic logic and research procedures in order to help the student evaluate the reliability of data and validity of conclusions contained in business reports. The second part of the course is devoted to a major field study. Each student develops a solution to a business problem and presents an oral and written report of the solution to both the faculty and the businessmen concerned. ½ unit. Prerequisite: Business Administration 540 or equivalent.

542. **Business and Society.** The position of the business enterprise as an institution in American society. The role of the businessman in that society. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

543. **Legal Problems of Business Management.** Past and current development of the legal climate in which business operates and in which managerial decisions are made; growth of the common law with its system of courts and procedure for law enforcement; the law of contracts, including various devices available for protection of creditors; legal problems involved in selecting a form of business organization. Students analyze business problems to see the importance of proper applications of the law to managerial decisions in regard to business policies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

544. **Executive Policies and Planning.** A course on policy construction at the executive level and the planning aspects of policy implementation. Builds a general management point of view. Study of company-wide situations from the vantage

point of the chief executive. Case method study with supporting readings. Develops integration and application of the subject matter of prior courses. 1 unit. Prerequisite: Completion of first year of the M.B.A. program or equivalent.

545. **Business Logistics.** Movement, distribution, and control of raw materials and finished goods; site selection for manufacturing, warehousing, and distribution facilities; transportation media, selection, inventory control, communications networks, and requirements for logistics control data. Emphasis is on developing an integrated logistics system for a company. ¾ unit. Prerequisite: Enrollment in second year of the M.B.A. program or consent of instructor.

551. **Financial Analysis.** An introduction to the subject of managerial finance, with emphasis on basic decisions of management and provision of capital resources. Techniques of profit planning and forecasting, evaluation of financial performance relative to control standards, and development of criteria for commitment of funds are stressed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

552. **Financial Management and Control, I.** An analysis of the tools and techniques of capital expenditure management, with emphasis on the relation of financial forecasting and control to criteria for investment planning and asset management. The theory of investment is examined, as well as the relation of organizational structure to capital planning policy. ¾ unit. Prerequisite. Business Administration 551.

553. **Financial Management and Control, II.** An analysis of the problems confronting corporate financial management in deciding appropriate methods of financing capital expenditure commitments. A thorough analysis of the specialized literature, coupled with the use of selected case material, forms the core of the course. ¾ unit. Prerequisite: Business Administration 552.

554. **Financial Theory and Policy.** Special problems of economic analysis and their relation to the functional discipline of managerial finance; includes study of techniques for forecasting financial requirements under uncertainty, problems of income determination, the relation of long-term capital commitments to uncertain payoff vectors, internal and external capital rationing, and problems of identifying capital supply functions. ¾ unit. Prerequisite: Business Administration 553, 573, and 576.

557. **Seminar in Finance.** Analysis of (1) financial policies and problems connected with corporate expansion through acquisition of interest in, or absorption of, established concerns, including an examination of the legal, economic, and financial background for business combination, or (2) specific problems of financial management in light of differing operating characteristics of major enterprise classifications, including opportunities for students to construct decision models for application to problems of financial management. ¾ unit. Prerequisite: Business Administration 554 and 573.

560. **Managerial Accounting and Control.** An analysis of managerial controls, the information needed for their operation, and the manner in which accounting provides that information; emphasis upon accounting as a tool of management. Problems and cases stress the type of figure information relevant to managerial decisions, and the methods of using such data. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

562. **Industrial Cost Control.** A study of cost accounting, with emphasis on the use of operating data by management for control purposes. Methods of material pricing, labor costs, including fringe benefits; indirect manufacturing costs, direct costing, standard costs; estimated and statistical costs; distribution costs; contribution to overhead theory; depreciation and replacement of equipment; selection of plant; decision to make or buy; relation between costs and pricing policy. ¾ unit. Prerequisite: Business Administration 560 or equivalent.

563. **Controllership.** The controller in the business organization: his property control responsibilities; internal check; internal audits; insurance; his assistance to operating management through budgeting, break-even analysis, profitability studies; his relationship with groups outside of management such as investors and government agencies; emphasis on manner in which figure function of controller is used to integrate the operations of the business enterprise. ¾ unit. Prerequisite: Business Administration 562 or equivalent.

570. **Mathematical Analysis for Business Decisions.** The use of classical mathematics in business decision-making; development of the concepts of total and marginal value analysis. Special emphasis is placed on the construction of quantitative models of business and economic systems, topics in bivariate and multivariate functions, differentiations, and integration. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

571. **Decision Theory.** Application of finite mathematics to business decision-making; an introduction to the theory of sets; partitions and counting; vectors and matrices, as well as Bayesian statistics. Major emphasis is placed on linear programming and the theory of games. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

572. **Modern and Classical Statistics for Business Decisions.** The application of classical and modern statistics for business decision-making; topics in probability distributions, variance analysis, and partial and multiple correlation analysis as well as the use of personal probabilities and utility theory. ¾ unit. Prerequisite: Business Administration 571.

573. **Introduction to Operations Research.** An introduction to operations research techniques; topics in integer, nonlinear, and dynamic programming, queueing theory, replacement, and Monte Carlo techniques; special projects in game theory applications in business. ¾ unit. Prerequisite: Business Administration 572; completion of first year of the M.B.A. program.

574. **Application of Operations Research Techniques.** The application of the operations research techniques developed in Business Administration 573 to practical business problems. Most of the semester is devoted to a series of field research studies. Prior to the field studies, a review of previous work in the field is made. The role of the computer in solving operations research problems, as well as its application to the field research, is also a major consideration. ¾ unit. Prerequisite: Business Administration 573.

575. **Business Simulation.** An introduction to the use of computers in solving business problems. Topics include the relation of integrated data processing systems to information flows within the firm and the development of simulation models of intrafirm decision processes. ¾ unit. Prerequisite: Business Administration 573.

576. **Business Forecasting and Econometrics.** An introduction to maximum likelihood estimating techniques. Topics include the use and limitations of least squares, two-stage least squares, limited-information and full-information estimates. Problems with observational errors, multi-colinearity, and auto-correlation in time-series and cross-section structural estimation are considered. A major portion of the course is devoted to the application of the econometric techniques in business forecasting and analysis. ¾ unit. Prerequisite: Business Administration 572.

582. **International Business Operations, I.** An integration of economics and the functional areas of business focused on the problems of managing international business operations. Economic, legal, functional, and administrative problems are studied through cases and literature emphasizing financial and marketing problems. Students select one of Europe, Latin America, Africa, Middle and Near East, or South Asia and Far East, for special study and reporting. ¾ unit. Prerequisite: Completion of first year of the M.B.A. program.

583. **International Business Operations, II.** Continuation of Business Administration 582. ¾ unit. Prerequisite: Business Administration 582.

590. **Independent Study and Research.** Directed reading and research. ½ or 1 unit.

599. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

373. **Electronic Data Processing for Business.** A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general business is considered. The facilities of the Digital Computer Laboratory are utilized in the course. ½ or 1 unit. Prerequisite: Economics 170; Accountancy 106 or 108. HINOMOTO, URETSKY, STAFF.

BUSINESS EDUCATION

The Department of Business Education offers graduate work leading to the Master of Science in Commercial Teaching. The work is part of an integrated five-year program for those preparing to become commercial teachers. Students may also take advanced degree programs in education, specializing in business education.

Students seeking admission in any area must have a grade-point average of 3.5. A limited number of the requirements listed below may be completed by extramural graduate study.

Candidates for the Master of Science in Commercial Teaching must earn three units in education, as described in (1) below; three units in commerce, consisting of two units from fields listed in (2) below and one unit from courses listed in (3) below (business education); and two units of electives. All courses must be selected with the approval of the student's adviser.

(1) Education. Three units consisting of Educational Psychology 311, 312, Vocational and Technical Education 456, and two of the following: History and Philosophy of Education 301, 302, 303, 304.

(2) Two units selected from accountancy, economics, industrial administration, and marketing.

(3) Commerce (business education). One unit selected from Business Education 361, 382, 383, 490, 499.

(4) Recommended electives. Two units selected from courses listed under (1) and (2), or not more than one unit from (3), or from courses in the following list: Secondary and Continuing Education 354, 439; Vocational and Technical Education 381, 459; Educational Psychology 390, 391, 411, 413, 422, 423, 425, 428; History and Philosophy of Education 401; and Educational Administration 460; Journalism 308. Other courses may be taken with the consent of the adviser.

The adviser for candidates for this degree is Professor Elizabeth R. Melson, 117 David Kinley Hall.

GRADUATE FACULTY

Professor: E. J. DEMARIS (Acting Head of Department).

Associate Professor: ELIZABETH R. MELSON.

Assistant Professor: MILDRED E. REED.

COURSES FOR GRADUATES

490. **Special Topics.** Directed reading and research. ½ or 1 unit. No credit for students electing to write a thesis.

499. **Thesis Research.** ½ to 2 units.

Note: See also Secondary and Continuing Education 456 and 459.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. **Teaching Office Management and Machine Operations.** Designed for high school and college teachers. Selection and use of machines, course content for machine courses, and organization of instructional material. S; ½ unit. Prerequisite: Secondary and Continuing Education 241; Educational Practice 242; sixteen hours in commerce, six of which must be in accountancy; one year of teaching experience. MELSON.

382. **Organization and Administration of Cooperative Part-Time Programs in Business Education.** Deals with background, aims, coordination techniques, and administrative policies for organizing and operating cooperative part-time programs in distributive and office occupations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor.

383. **Problems in Cooperative Education.** Students apply for and secure distributive or office positions with selected cooperating business firms. While regularly employed in these supervised positions, they observe the relationships between those activities and the cooperative business education programs in the high school. These relationships are pointed up through regularly scheduled class meetings where emphasis is placed on job analysis, current trends, wage and benefit structure, personnel practices, and labor relations. S; 1 unit. Prerequisite: Sixteen hours in education; sixteen hours in commerce; consent of instructor.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers work leading to the Master of Science and Doctor of Philosophy in Ceramics or in Ceramic Engineering. The prerequisite for graduate study in these areas is proficiency in the undergraduate courses required for the Bachelor of Science in Ceramic Engineering at the University of Illinois, or acceptable equivalents.

A minimum grade-point average of 3.75 for the last sixty hours of undergraduate work is required for admission. Students with grade-point averages between 3.75 and 4.0 are considered on an individual basis. Students who have bachelor's degrees in chemistry, physics, geology, or engineering may become candidates in this department, but they must make up deficiencies in ceramics.

A candidate for the Master of Science in Ceramics or Ceramic Engineering must complete a minimum of eight units of graduate work including a thesis.

Candidates for the Doctor of Philosophy in Ceramics or Ceramic Engineering are required to pass the departmental qualifying examination.

Candidates for the Doctor of Philosophy in Ceramics must present the equivalent of twenty-five semester hours of courses in inorganic, analytical, physical, and organic chemistry; calculus, including differential equations; one year of college physics; and a minimum of eighteen semester hours or equivalent in acceptable ceramics courses.

The most common minors selected by graduate students in ceramics or ceramic engineering are chemistry, physics, mathematics, geology, or other engineering disciplines.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramics prerequisite.

GRADUATE FACULTY

Professors: A. L. FRIEDBERG (Head of Department), A. W. ALLEN, R. L. COOK, F. V. TOOLEY.

Associate Professors: C. G. BERGERON, J. A. NELSON, V. J. TENNERY, T. A. WILLMORE.

Assistant Professor: G. S. SNOW.

COURSES FOR GRADUATES

401. **Ceramic Chemistry.** Silica, silicates, fusions, and phase relations. 1 unit. Prerequisite: Courses in chemistry and physics.

402. **Ceramics.** Chemical and physical phenomena. 1 to 2 units. Prerequisite: Courses in physics and chemistry.

405. **Glass Technology.** This course, following a brief review of unit processes and operations in glass manufacture, treats from a dominantly theoretical and research point of view selected major topics relating to the glass preparation process and the chemical, mechanical, optical, and electrical properties of glass. ¾ unit. Prerequisite: Ceramic Engineering 301 or equivalent, or consent of instructor. TOOLEY.

406. **Glass Technology.** This course is dominantly theoretical in approach. Following a survey of the basic theoretical ideas that have been used in the development of the glass model, student readings and reports from the classical and modern literature serve as the basis of class discussions on glass structure and behavior, with emphasis on structure property correlations. ¾ unit. Prerequisite: Ceramic Engineering 405 or consent of instructor. TOOLEY.

407. **Porcelain Enamels.** This course covers the fundamental scientific principles involved in the area of porcelain enameling and the properties of such coatings. 1 or 1½ units (includes laboratory if taken for more than one unit). Prerequisite: Ceramic Engineering 222 and 320, or equivalent.

409. **Whitewares.** Advanced study in the field of whitewares, including fundamental considerations of glazes and all types of ceramic bodies. Special emphasis is placed on new developments in research and processing. Considerable attention is given to the ferroelectric and ferromagnetic properties of electronic ceramics. 1 or 1½ units (includes laboratory if taken for more than one unit). Prerequisite: Ceramic Engineering 309; Ceramic Engineering 340 or equivalent. COOK.

410. **Dielectric Properties of Ceramic Materials.** Fundamental properties of vector fields are reviewed. The reaction of insulating solids to external electric fields is considered in terms of dielectric theory. The properties of ceramic dielectrics including ferroelectrics are treated in terms of present theory. The piezoelectric properties of ferroelectric crystals and ceramics are correlated with the crystal structure, microstructure, and the ferroelectric properties. ¾ unit. Prerequisite: Mathematics 345 and 343, or consent of instructor. TENNERY.

412. **Structural Physical Ceramics.** Structural chemistry and crystallization behavior of ceramic systems at elevated temperatures; nucleation, crystal growth; mineral synthesis; high-temperature reaction kinetics, including phase transformations and diffusion. ¾ unit. SNOW.

421. **High-Temperature Technology.** A review of the methods of achieving and controlling high temperatures, both in industrial processes and in the laboratory, combined with a study of the techniques for measuring the properties of materials at elevated temperatures emphasizing oxides, carbon and graphite, silicates, carbides, borides, silicides, nitrides, sulfides, cermets, and refractory metals. A correlation of the physical and chemical behavior of these materials with their crystal structure, microstructure, and physical form is emphasized where possible. ¾ unit. Prerequisite: Ceramic Engineering 310. ALLEN.

422. **High-Temperature Technology Laboratory.** Laboratory to accompany Ceramic Engineering 421, with emphasis on instrumentation for and measurement of properties at elevated temperature. Analytical interpretation of data in numerical problems is included. ½ unit. Prerequisite: Credit or registration in Ceramic Engineering 421, or consent of instructor. ALLEN.

461. **Mineralogy of Clays.** Same as Geology 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. **Mineralogy of Clays.** Same as Geology 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. GRIM.

495. **Materials and Special Problems.** Conference and laboratory. 0 to 2 units.

499. **Thesis Research.** Research in any of the branches of ceramics. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Chemistry and Technology of Glass.** This course augments some of the subject matter of Ceramic Engineering 214, and develops additional subject matter relating to the theory of glass formation and structure and the behavior of glass as a function of composition, structure, and heat treatment. Students taking this course gain improved qualifications for research work in the field. ½ unit. Prerequisite: Ceramic Engineering 214 or consent of instructor. TOOLEY.

307. **Thermal and Mechanical Properties of Ceramic Materials.** Interpretations of the thermal and mechanical behavior of real ceramic materials utilizing the atomistic concepts of structure correlated with characterized microstructure. Half of the course treats the mechanism of thermal dilatation, heat transport and emission. The remainder integrates the characterization of deformation including elastic, anelastic, plastic, and viscous behavior. Temperature dependency is stressed throughout. Lectures and laboratory. ¾ unit. Prerequisite: Ceramic engineering 216, 331, or equivalent; Theoretical and Applied Mechanics 154 and 221. SNOW.

309. **Whiteware Materials.** A study of the characteristics and engineering properties of multi-phase polycrystalline aggregates and vitreous complexes including the raw material preparation, fabrication, and processing. Special emphasis is placed on the single and multi-oxide component bodies, including the crystallographic structures of the alkaline earth titanates and the ferritic spinels as whiteware materials. ¾ unit. Prerequisite: Ceramic Engineering 216 or equivalent. COOK.

310. **Refractory Technology.** A study of the engineering properties and thermochemistry of polycrystalline materials for use at elevated temperatures, including processing of raw materials, the manufacture, heat treatment, quality control, and specification of refractory products. Particular emphasis is placed on oxides, silicates, carbides, borides, cermets, and refractory metals, with a correlation of the properties of those materials to certain design criteria. ¾ or 1 unit (includes laboratory if taken for one unit). Prerequisite: Ceramic Engineering 307. ALLEN.

320. **Advanced Porcelain Enamels.** An advanced study of the field of porcelain enamels with particular emphasis on fundamentals of bond or adherence of enamel metal systems, on opacity and mechanism of color development and measurement, and on the thermal and chemical properties of coatings on metal. Specific attention is given to coatings for use on metals at elevated temperatures. ½ unit. Prerequisite: Ceramic Engineering 222 or consent of instructor. COOK.

331. **Ceramic Microscopy.** A study of the optical activity in isotropic and anisotropic media with particular emphasis on the materials and products of ceramics; the application of these principles and related topics of optical microscopy to the study of the morphology, aggregation, size, and microstructure of the products of high-temperature thermochemical reactions and equilibria. ¾ or 1 unit (includes studies in thermal microscopy if taken for one unit). Prerequisite: Ceramic Engineering 205 and 216, or consent of instructor. ALLEN.

340. **Electrical Ceramics.** The subject of electric crystals and their electrical properties is presented; the ferroelectric and piezoelectric properties of several crystal classes are discussed and correlated; the perovskite class of ferroelectric compounds is covered in detail; spinel, garnet, and hexagonal type ferrimagnetic crystals and their properties are discussed. ¾ unit. Prerequisite: Ceramic Engineering 309 or consent of instructor. TENNERY.

CHEMICAL PHYSICS

Fundamental research on many properties of molecular and solid state systems is based on an understanding of chemistry, physics, and mathematics that can best be obtained by training in more than one department of the University. A program leading to the Doctor of Philosophy in Chemical Physics makes it possible for students to gain the necessary background and perform original research in this interdisciplinary field of science.

Applicants for admission should have undergraduate degrees in chemistry or physics, a grade-point average of at least 4.0, and a strong background in the major field of chemistry or physics, with more than the usual training in the other area. Those who received their degrees in physics should have the equivalent of one semester each of organic and inorganic chemistry and one year of physical chemistry. Those who received their degrees in chemistry should have the equivalent of one semester each of intermediate mechanics and intermediate electricity and magnetism. One year of mathematics beyond calculus is recommended. Deficiencies should be removed during the first year of study.

In addition to satisfying the requirements of the Graduate College, students must pass either the qualifying examination in the Department of Physics or the set of cumulative examinations given by the Division of Physical Chemistry. A knowledge of the content of Chemistry 348 and 349 or Physics 362 and 381 must be demonstrated also (for example, by passing the final examinations in these courses).

The program of graduate study consists of courses in the areas of mathematics, physics, and chemistry. A one-year course in quantum mechanics must be included, and the other courses must be selected from the three areas with the approval of the Committee on Chemical Physics.

Research for the dissertation is performed under the direction of staff members who are currently active in chemical physics. Students may apply for fellowships and assistantships and may make use of the facilities available in the Departments of Chemistry and Chemical Engineering and Physics.

Students with undergraduate degrees in chemistry should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering; students with undergraduate degrees in physics should direct inquiries and applications to the head of the Department of Physics.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering. Attention is also called to a joint program leading to the Doctor of Philosophy in Chemical Physics (see above) and to the program in Biophysical Chemistry (see pages 81, 92, and 284).

Admission Requirements. Students at the University of Illinois who have fulfilled the usual undergraduate course requirements may apply for entrance to the Graduate College in chemistry or chemical engineering if they have a grade-point average of 4.0.

Students who have completed graduate work in chemistry or chemical engineering and related subjects at another institution may be admitted, provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0 Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Students whose undergraduate records have not met the above requirements must have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution in order to be admitted to the Graduate College in chemistry or chemical engineering.

Students who are candidates for admission to the Graduate College in chemistry or chemical engineering must have had the equivalent of twenty-five semester hours in chemistry properly distributed.

Graduate students whose major subject is in some department other than chemistry and chemical engineering must have had the equivalent of fifteen semester hours in chemistry, including satisfactory work in general chemistry, qualitative and quantitative analysis, and elementary organic chemistry. Such students are advised to make selections from the following courses: Chemistry 315, 316, 321, 336, 337, 342, 343, 344, 345, 350, and 355. Courses of a more special nature are not, as a rule, accepted for graduate work unless preceded by one or more of the above courses.

Master of Science in the Teaching of Chemistry. Candidates for the Master of Science in the Teaching of Chemistry must meet the requirements for the Master of Science in Teaching of the Physical Sciences (page 283).

CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engineering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science must include two chemical engineering courses at the 400 level in their programs.

BIOCHEMISTRY

The Biochemistry Division of the Department of Chemistry and Chemical Engineering administers the graduate program in biochemistry. The curriculum is composed of Chemistry 350, 355, 450, 452, and 494 (same as Microbiology or Biophysical Chemistry 494), and selected offerings in allied chemical and biological areas. Interested students are invited to contact the biochemistry staff.

BIOPHYSICAL CHEMISTRY

The Department of Chemistry and Chemical Engineering, in collaboration with the Department of Microbiology, offers an area of specialization in biophysical chemistry. The program is flexible and provides the student with basic training in physical biochemistry and biology. Students electing this area should have a solid background in physics and mathematics. Details of the curriculum are decided individually. It is expected, however, that the student fulfill minor requirements in microbiology or some other biological science.

Courses in the Department of Chemistry and Chemical Engineering especially related to this curriculum are Chemistry 346, 452, and 494 (same as Microbiology 494). Related courses also are offered in the Department of Microbiology (Microbiology 330, 405) and in the Biophysical Division of the Department of Physiology and Biophysics (Biophysics 301, 401, 402, and 403).

GRADUATE FACULTY

Professors: H. E. Carter (Head of Department), H. A. Laitinen (Associate Head of Department), D. E. Applequist, J. C. Bailar, Jr., T. L. Brown, D. Y. Curtin, R. S. Drago, H. G. Drickamer, I. C. Gunsalus, H. S. Gutowsky, L. P. Hager, T. J. Hanratty, J. W. Hastings, N. J. Leonard, H. V. Malmstadt, R. A. Marcus, J. C. Martin, T. Moeller, R. F. Nystrom, K. L. Rinehart, G. A. Sim, H. R. Snyder, S. Swann, Jr., K. E. Van Holde, G. Weber, J. W. Westwater, P. E. Yankwich.

Associate Professors: R. L. Belford, W. H. Flygare, A. M. Hartley, J. P. Hummel, R. S. Juvet, J. A. Quinn, S. G. Smith, F. Wold.

Assistant Professors: J. E. Baldwin, P. Beak, V. A. Bloomfield, J. L. Brownlee, Jr., J. M. Clark, R. M. Coates, H. E. Conrad, C. A Ecker, J. Goodisman, J. L. Hudson, J. G. Kay, I. C. Paul, C. E. Pfluger, W. H. Pirkle, R. L. Sani, R. A. Schmitz, G. J. Schroepfer, Jr., D. H. Secrest, G. D. Stucky, L. J. Todd, R. W. Woody.

Chemistry

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. 1 unit. MOELLER.

404. **Advanced Inorganic Chemistry Laboratory.** Specialized laboratory techniques; more difficult inorganic syntheses. 1/4 to 3/4 unit. Prerequisite: Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. 1/4 unit.

406. **Physical Inorganic Chemistry.** Qualitative description of the bonding in inorganic compounds; use of physical methods to provide information about the structure and reactions of inorganic compounds; structures and reactions of inorganic compounds in solution. 1 unit. Prerequisite: Chemistry 315 and 344.

407. **Special Topics in Inorganic Chemistry.** Discussions of newly developing areas of inorganic chemical research. 1/4 to 1 unit. Prerequisite: Graduate standing in chemistry. KAY.

408. **The Chemistry of Complex Inorganic Compounds.** The nature of the coordinate bond; applications of complex compounds. 1 unit. Prerequisite: Chemistry 315.

421. **Spectrochemical Methods of Analysis.** Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree. MALMSTADT.

422. **Electrical Methods of Chemical Analysis.** Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. 1 unit. Prerequisite: Chemistry 344 or equivalent. LAITINEN.

423. **Electron Microscopy.** Same as Biology and Zoology 423. Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Open to qualified graduate students in any department. 1/4 unit. Prerequisite: Adequate background in chemistry, physics, and mathematics; consent of instructor. HALL.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods, and applications. 1/2 unit. HARTLEY, LAITINEN.

425. **Analytical Chemistry.** Seminar. Required of all graduate students whose major is analytical chemistry. 1/4 unit. LAITINEN, STAFF.

426. **Applied X-Rays.** Lectures. 3/4 unit. Prerequisite: Training in physics and physical chemistry. PFLUGER.

427. **Applied X-Rays: Crystallography.** Lectures. 3/4 unit. Prerequisite: Training in physics and physical chemistry.

428. **Applied X-Rays.** Laboratory. Training in operation of all types of x-ray apparatus with special emphasis on diffraction; experimental chemical identification and crystal structure analyses from powder and single crystal patterns. 1/4 to 1 unit. Prerequisite: Credit or registration in Chemistry 426 or 427. PFLUGER.

429. **Electron Microscopy Laboratory.** Same as Biology and Zoology 429. Essentially individual instruction. Detailed training in operation and care of electron microscopes (four types); preparation of specimens including microtomy, electron staining, replication, and shadow casting; measurements and interpretations; special projects related to student's research interests. Open to qualified graduate students in any department. 1/2 or 3/4 unit. Prerequisite: Adequate background in chemistry, physics, and mathematics; credit or registration in Chemistry 423; consent of instructor. HALL, PAGE.

430. **Organic Chemistry.** Survey of organic chemistry for graduate students. 1 unit. Prerequisite: One year of organic chemistry.

431. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on reaction mechanisms and synthesis. 1 unit. Prerequisite: Chemistry 430 or 336; one year of physical chemistry.

432. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on structure. 1 unit. Prerequisite: Chemistry 431 or 336.

433. **Organic Chemistry.** Special topics in organic chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as natural product synthesis and biosynthesis, organic photochemistry, chemistry of special families of organic compounds, etc. ½ or ¾ unit; ¾ unit requires two lectures per week. Students may repeat this course for credit. Prerequisite: Chemistry 431 and 432, one of which may be taken concurrently.

434. **Advanced Organic Synthesis.** Lecture and laboratory. ¼ to 1 unit.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. ½ unit. Prerequisite: Consent of instructor.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. 1 unit. Prerequisite: Consent of instructor.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and their molecular interpretation; determination and chemical use of thermodynamic quantities. 1 unit. Prerequisite: Chemistry 342 and 344, or equivalent.

442. **Statistical Thermodynamics.** Basic principles of classical and quantum statistics with applications to chemistry. 1 unit. Prerequisite: Chemistry 441 and 446, or consent of instructor.

445. **Physical Chemistry.** Seminar. Required of all graduate students whose major is physical chemistry. ¼ or ½ unit. Prerequisite: Consent of instructor. YANKWICH.

446. **Quantum Chemistry, I.** An introduction to quantum mechanics: basic theory and methods of approximations; applications to atomic systems. 1 unit. Prerequisite: Chemistry 349 and Mathematics 388, or equivalent; consent of instructor.

447. **Quantum Chemistry, II.** Continuation of Chemistry 446. Application of quantum mechanics to chemical problems; theories of the chemical bond; structure and spectra of molecules. 1 unit. Prerequisite: Chemistry 446 or equivalent; consent of instructor.

448. **Chemical Kinetics.** Chemical reaction and the theory of rate processes. Lectures. ¾ unit. Prerequisite: Chemistry 441 or consent of instructor.

449. **Special Topics in Physical Chemistry.** An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. Students may register for credit more than once. ½ or 1 unit. Prerequisite: Consent of instructor.

450. **Chemistry of Biological Processes.** A consideration at the molecular level of biological processes including bioenergetics, biosynthetic and degradative pathways of cellular components, metabolic regulation and enzyme reaction mechanisms. 1 unit. Prerequisite: Chemistry 350 and 355. GUNSALUS, WEBER.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. ¾ or 1 unit. Prerequisite: Chemistry 350 and 355. HASTINGS, TODD.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. ½ unit. Prerequisite: Chemistry 350 and 355, or equivalent. GUNSALUS, STAFF.

494. **Chemical Basis of Biological Specificity.** Same as Microbiology 494. Biological formation and interaction of large molecules; analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles; nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; metabolic interrelations of these molecules. ¾ unit. Prerequisite: Chemistry 344, 346, and 350, or 450; Microbiology 330; or consent of instructor. NISONOFF, SPIEGELMAN, WEBER.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Animal Science 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. NYSTROM.

499. **Thesis Research.** A candidate for the master's degree who elects research is required to present a thesis. A thesis is always required of students working toward the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in a department other than chemistry must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. Work may be taken in the following fields, subject to the approval of one of the qualified staff members:

Analytical Chemistry. BROWNLEE, HARTLEY, JUVET, LAITINEN, MALMSTADT, PFLUGER.

Biochemistry. CARTER, CLARK, CONRAD, GUNSALUS, HAGER, HASTINGS, SCHROEPFER, C. W. TODD, WEBER, WOLD.

Biophysical Chemistry. BLOOMFIELD, HASTINGS, PAUL, VAN HOLDE, WEBER, WOLD, WOODY.

Inorganic Chemistry. BAILAR, BROWN, DRAGO, KAY, MOELLER, STUCKY, L. J. TODD.

Organic Chemistry. APPLEQUIST, BALDWIN, BEAK, CURTIN, LEONARD, MARTIN, PIRKLE, RINEHART, SMITH, SNYDER.

Physical Chemistry. BELFORD, BLOOMFIELD, DRICKAMER, FLYGARE, GOODISMAN, GUTOWSKY, HUMMEL, MARCUS, PAUL, SECREST, SIM, VAN HOLDE, WOODY, YANKWICH.

Chemistry:

Applied Electrochemistry—Organic and Inorganic. SWANN.

Radiochemistry. BROWNLEE, HUMMEL, KAY, NYSTROM.

Research for the Doctor of Philosophy is also offered in specialized fields other than those illustrated above. Students who intend to major in chemistry in one of these special fields should consult with the professor in charge of the thesis and with the head of the Department of Chemistry and Chemical Engineering in regard to the programs of courses and examinations.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and their compounds; types of bonding; survey of the periodic relationships; preparation and applications of the elements and their compounds. ¾ unit. Prerequisite: Credit or registration in physical chemistry.

316. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. ½ unit. Prerequisite: Credit or registration in Chemistry 315.

321. **Chemical and Instrumental Analysis.** Chemical and instrumental methods of analysis and their application to the quantitative study of chemical reactions. ¾ to 1¼ units. Prerequisite: Chemistry 336 and 340 or 342 with registration in Chemistry 343 and 344. STAFF.

322. **Analytical Separations and Experimental Design.** Quantative study of separations by chemical and instrumental analytical methods. Application of statistics to separation methods, to experimental design, and to interpretation of experimental data. ¾ unit. Prerequisite: Chemistry 321 or equivalent. JUVET.

323. **Electronics for Chemists.** Laboratory experimentation with basic instrument components, servo systems, operational amplifiers, digital circuits, and other circuits and devices used in modern instruments for scientific research. Discussions of basic principles and specific instruments. ½ unit. Prerequisite: Chemistry 321 or consent of instructor. MALMSTADT.

336. **Organic Chemistry.** Second course. Lectures and recitations. ¾ unit. Prerequisite: Chemistry 133 with a grade of A or B, or Chemistry 234.

337. **Organic Chemistry.** Laboratory experiments in organic chemistry. ½ unit. Prerequisite: Credit or registration in Chemistry 336.

338. **Systematic Identification of Organic Compounds.** 1 unit. Prerequisite: Chemistry 336 and 337, or equivalent.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. ¾ unit. Prerequisite: Chemistry 338 or consent of instructor.

340. **Principles of Physical Chemistry.** A one-semester course in physical chemistry emphasizing topics most important to students in the biological and agricultural sciences. Not open to students in the specialized curricula in chemistry or chemical engineering. 1 unit. Prerequisite: Physics 102; Chemistry 122 and 133, or equivalent; Mathematics 132 or equivalent.

341. **Elementary Physical Chemistry Laboratory.** A laboratory course to accompany Chemistry 340. ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a year-long study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. ¾ unit. Prerequisite: Chemistry 108, 122, 123, or equivalent; Physics 106, 107, and 108, or two semesters of general physics with concurrent registration in the third semester; credit or registration in Mathematics 142 or equivalent. STAFF.

343. **Physical Chemistry Laboratory.** Quantitative experimental study of chemical principles, Chemistry 343 and 345 constitute a year-long introduction to experimental physical chemistry. These courses may be taken consecutively or concurrently. ¼ unit. Prerequisite: Chemistry 342. STAFF.

344. **Physical Chemistry Laboratory.** Continuation of Chemistry 342. ¾ unit. Prerequisite: Chemistry 342. STAFF.

345. **Physical Chemistry.** Continuation of Chemistry 343. May be taken concurrently with Chemistry 343. ¼ unit. Prerequisite: Chemistry 342; credit or registration in Chemistry 343 and 344. STAFF.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins and high polymers; the use of physical methods for the characterization of such substances. ¾ or 1 unit (laboratory required for one unit). Prerequisite: Chemistry 340 or 344; consent of instructor.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. 1 unit. Prerequisite: Chemistry 344 or equivalent.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. 1 unit. Prerequisite: Chemistry 348.

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent. CLARK, HAGER.

351. **Metabolic Processes: Problems and Methods.** Laboratory experiments stress methods of conducting metabolic experiments with tissues, cells, cell components, and enzymes. Weekly discussions consider present concepts of the mechanism of chemical transport, hormone control, energy release, and of biosynthesis. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Chemistry 350 and 355. HASTINGS.

354. **Introduction to Biochemistry.** Lectures: Structure and function of living matter, with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. 1 unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor. CONRAD.

355. **Biochemistry Laboratory.** To accompany Chemistry 350. An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituents and transformations in biological systems. Laboratory, quizzes, and assigned readings. Required of all students who expect to take advanced courses in biochemistry. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; registration in Chemistry 350. WOLD.

391. **Special Problems in Introductory Chemistry.** Designed to strengthen the chemical background of high school and junior college teachers and to integrate teaching of high school and college chemistry courses. Lectures, conferences, problems, and reports. Adaptable to individual needs. ½ or 1 unit. Prerequisite: Experience in teaching chemistry in high school or junior college.

393. **The Status of Modern Chemistry.** Lectures, demonstrations, discussions, and literature assignments in specialized areas of chemistry and chemical engineering, including analytical, inorganic, organic, and physical chemistry, biochemistry, and chemical engineering. Designed to broaden and strengthen the base of experience and knowledge of high school and junior college chemistry teachers. S; ¾ or 1 unit. Prerequisite: Experience in teaching chemistry in high school or junior college.

395. **History of Science with Particular Reference to Chemistry.** ½ unit. Prerequisite: Twenty hours of laboratory science. CAMERON.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interac-

tion with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345. It is recommended that chemistry majors take Chemistry 344 before registering in this course; concurrent registration in Physics 385 is also recommended.

397. **Radiochemistry.** Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor. HUMMEL.

398. **Radiochemistry Laboratory.** Same as Nuclear Engineering 398. To accompany Chemistry 397. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. Laboratory and discussions. ½ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor. HUMMEL.

Chemical Engineering

COURSES FOR GRADUATES

464. **Transport Phenomena.** Analysis of the various phenomena associated with transport processes; mechanism and phenomenological description; equations of change; interphase transport. Application to systems involving the transfer of energy, mass and momentum. 1 unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 373 or consent of instructor.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. ¼ unit. Prerequisite: Chemical Engineering 373.

466. **Applied Mathematics in Chemical Engineering.** The development of mathematical models and a survey of modern mathematical methods currently used in the solution of chemical engineering problems. Topics include the application of vectors and matrices, partial differential equations, numerical analysis, and methods of optimization in chemical engineering. ¾ or 1 unit. Prerequisite: Consent of instructor.

468. **Properties of Fluids.** The kinetic theory of gases and the prediction of transport coefficients; statistical mechanics applied to dense gases and liquids; theories of solutions. ¾ or 1 unit. Prerequisite: A background in modern physical chemistry and physics; consent of instructor.

469. **Special Topics in Chemical Engineering.** Various advanced topics are covered from time to time. These are generally taken during the second year of graduate study. Typical topics include turbulence, hydrodynamic instability, process dynamics, interfacial phenomena, reactor design, properties of matter at high pressure, phase transitions. ¾ or 1 unit. Prerequisite: Chemical Engineering 464.

487. **Fluid Dynamics.** Basic concepts in fluid dynamics with special emphasis on topics of interest to chemical engineers. Derivation of the Navier-Stokes equations; solutions for creeping flow, for perfect fluids, and for boundary layers; non-Newtonian fluids; turbulence. 1 unit. Prerequisite: Chemical Engineering 464.

488. **Advanced Topics in Heat and Mass Transfer.** Principles of transfer operations developed in terms of physical rate processes. Boundary layer heat and mass transfer, eddy diffusion, phase changes, and separation processes. ¾ or 1 unit. Prerequisite: Chemical Engineering 464 or consent of instructor.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. DRICKAMER, ECKERT, HANRATTY, HUDSON, QUINN, SANI, SCHMITZ, SWANN, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Science 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Prerequisite: Chemistry 340 or 342 or consent of instructor; one year of calculus.

367. **Introduction to Process Control.** An introduction to the control of industrial chemical processes. Lecture and laboratory. ¾ unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 371.

368. **Chemical Engineering Kinetics.** Principles of reaction kinetics and applications to reactor design. ¾ unit. Prerequisite: Chemical Engineering 370.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342.

371. **Principles of Chemical Engineering.** Introduction to fluid dynamics and heat transfer. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor.

373. **Principles of Chemical Engineering.** Introduction to mass transfer operations. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 371.

374. **Unit Operations Laboratory.** To accompany Chemical Engineering 373. Laboratory and computations in the unit operation. ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373.

377. **Process Dynamics.** The basic ideas of process dynamics and their applications in chemical engineering. ¾ unit. Prerequisite: Chemical Engineering 367 or consent of instructor.

379. **Chemical Engineering Projects.** Laboratory. Development of an individual project. ½ unit. Prerequisite: Senior standing in chemistry or chemical engineering.

380. **Heat, Mass, and Momentum Transport.** A unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. ¾ unit. Prerequisite: Mathematics 343 or 345; Chemical Engineering 371; or consent of instructor.

381. **Chemical Engineering Plant Design.** Comprehensive problems, lectures, and discussion on plant design and the economic factors involved in design and operation of chemical plants. ½ unit. Prerequisite: Chemical Engineering 373.

382. **The Prediction of Physical Properties.** The prediction of equilibrium and transport properties in gases, liquids, and solids. ½ unit. Prerequisite: One year of physical chemistry.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The Department of Civil Engineering offers a combination of advanced study and participation in creative research in order to meet the needs of individual students. Such graduate training prepares students to assume greater responsibilities and to contribute to the progress of the civil engineering profession. Graduate study and active research can be pursued in the following fields: air pollution; behavior, analysis and design of structures; properties of structural material; construction engineering and management; digital computer applications; foundation engineering; highways and transportation; hydrology and water resources, hydromechanics, and hydraulic structures; models research; photogrammetry and photointerpretation; radiological health; rock and soil mechanics; systems engineering; traffic engineering; urban planning and management; waste water treatment; water quality and treatment.

In 1966 several divisions of the department occupied new quarters in a $4 million building especially designed for modern teaching and research. A $3 million addition, to be completed in 1968, will offer additional space to supplement the other campus areas used by the department in teaching and research.

The Master of Science and Doctor of Philosophy in Civil Engineering may be attained by qualified students who satisfy the requirements of the department and the Graduate College. Progress toward an advanced degree is measured not only by the accumulation of units of credit in formal course work but also by evidence of intellectual growth and achievement. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the Bachelor of Science in the branch of the subject in which registration is desired.

The Master of Science and Doctor of Philosophy are offered in Sanitary Engineering. The prerequisite for admission to the first year of graduate study is a Bachelor of Science in Engineering or in one of the physical or life sciences.

Admission to the Graduate College with full status in civil or sanitary engineering is granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois, provided the applicant's preparation is appropriate to advanced study in his chosen major field and his scholastic average is at least 4.0. Under certain conditions, applicants with a grade-point average of less than 4.0, and applicants from schools with different grading systems, may be considered if their average is equivalent to or higher than 3.75 and evidence is submitted indicating that the applicant's ability is not appropriately measured by the grades submitted.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor must be approved by the head of the department.

A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units are required.

A pamphlet entitled *Graduate Study and Research in Civil and Sanitary Engineering* is available upon request to the head of the departments, Civil Engineering Hall, Stoughton and Romine streets.

GRADUATE FACULTY

Professors: N. M. Newmark (Head of Department), A. H. S. Ang, J. E. Baerwald, J. W. Briscoe, A. B. Chilton, V. T. Chow, E. Danner, D. U. Deere, R. S. Englebrecht, R. A. Eubanks, B. B. Ewing, S. J. Fenves, E. H. Gaylord, W. J. Hall, J. D. Haltiwanger, W. W. Hay, M. Herrin, H. O. Ireland, C. E. Kesler, N. Khachaturian, T. E. Larson, M. B. McPherson, W. H. Munse, J. P. Murtha, J. E. Pearson, R. B. Peck, A. R. Robinson, M. O. Schmidt, L. R. Shaffer, C. P. Siess, G. K. Sinnamon, M. A. Sozen, J. E. Stallmeyer, T. H. Thornburn.

Associate Professors: E. Chesson, Jr., M. T. Davisson, H. M. Karara, T. K. Liu, V. J. McDonald, J. L. Merritt, Jr., R. J. Mosborg (Assistant Head of Department), J. T. O'Connor, R. E. Olson, A. F. Richards, W. C. Schnobrich, R. E. Speece, R. N. Wright.

Assistant Professors: J. H. Austin, E. J. Barenberg, D. M. Brown, R. I. Dick, G. C. Feng, W. L. Gamble, G. Gracie, A. J. Hendron, E. R. Holley, Jr., W. H. C. Maxwell, J. W. Melin, N. N. Nielsen, S. L. Paul, K. Preiss, J. B. Radziminski, H. J. Rainer, N. O. Schmidt, M. R. Thompson, C. C. Tung, W. H. Walker, H. G. Wenzel, Jr., C. Y. Yang, P. Constance Yang.

COURSES FOR GRADUATES

401. **Geodetic Engineering.** Elements of geodesy; principles and practice of precise triangulation, traverse, and levels. 1 unit. Prerequisite: Bachelor of Science in civil engineering. SCHMIDT.

403. **Photogrammetry.** Study of the principles of stereoscopy and geometrical optics; aerial cameras, their design and calibration; the design, construction, and operation of stereoscopic plotting machines; mathematics of stereoscopic orientation and model deformations. 1 unit. Prerequisite: Civil Engineering 302 or consent of instructor. KARARA.

404. **Photogrammetry.** Theory of errors of stereoscopic photogrammetry; aerotriangulation (spatial and radial), its theory and applications to various civil engineering problems; electronics in photogrammetry; practice in compiling maps from aerial and terrestrial photographs. 1 unit. Prerequisite: Civil Engineering 302 or consent of instructor. KARARA.

416. **Design of Construction and Industrial Operations, I.** Same as Industrial Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor. SHAFFER.

417. **Design of Construction and Industrial Operations, II.** Same as Industrial Engineering 417. Continuation of Civil Engineering 416. 1 unit. Prerequisite: Civil Engineering or Industrial Engineering 416; credit or registration in Mathematics 315; or consent of instructor. SHAFFER.

420. **Pavement Design, I.** Analysis and methods of measurement of surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper surface properties, load carrying capacity, wear resistance, stability, and durability. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. DANNER.

421. **Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. HERRIN.

426. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. 1 unit. Prerequisite: Civil Engineering 325 or equivalent. BAERWALD.

427. **Geometric Highway Design.** Highway classification; highway capacity; highway design controls; sight distance; horizontal and vertical alignment; cross section elements; highway types; controlled access highways; design of at-grade intersections, grade separations, and interchanges. 1 unit. Prerequisite: Civil Engineering 325 and 426, or consent of instructor. BAERWALD.

428. **Traffic Engineering Operations.** Theory of traffic control; laws and ordinances; design and application of traffic control devices; special street designations; parking design and control; street illumination; miscellaneous traffic control designs. 1 unit. Prerequisite: Civil Engineering 325 and 426, or equivalent. BAERWALD.

435. **Railway Construction and Maintenance.** Roadbed load capacity; economic design of track; advanced geometric design; economics of maintenance; grade crossing separations; review of specific projects. 1 unit. Prerequisite: Civil Engineering 335. HAY.

436. **Railroad Location and Operation.** Track and traffic capacity; optimum train size, performance, and scheduling; validity and accuracy of current practices; regional operating factors; optimum size of plant and modern location. 1 unit. Prerequisite: Civil Engineering 336 or consent of instructor. HAY.

440. **Theory of Water Treatment.** Properties of water and criteria of water quality; gas transfer operations in water treatment; chemical treatment processes; corrosion and corrosion control; sedimentation; filtration; disinfection; control of aquatic growths; control of tastes and odors. 1 unit. Prerequisite: Chemistry 122 and Microbiology 101. DICK, EWING.

441. **Analysis and Treatment of Water and Waste Water.** Physical, biological, and chemical analysis of water and waste water; field sampling techniques; removal of objectionable impurities, principles of disinfection; determination of dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand; nitrogen, sulfur, and phosphorous compounds in waste waters. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440. O'CONNOR.

442. **Theory of Waste-Water Treatment.** Composition, properties, and analysis of wastes; microbiology of waste treatment; pollution of natural waters; sedimentation; chemical treatment; aerobic and anaerobic treatment processes; disposal of waste sludges. 1 unit. Prerequisite: Civil Engineering 346; Chemistry 122; Microbiology 101. AUSTIN, ENGELBRECHT.

443. **Advanced Sanitary Engineering Laboratory.** Experimental and pilot plant studies of the operational characteristics for various physical, chemical, and biological unit operations and processes used in the treatment of water and waste water. 1 unit. Prerequisite: Civil Engineering 441; credit or registration in Civil Engineering 442. O'CONNOR.

444. **Industrial Water and Wastes Treatment.** The theory and application of unit operations unique to the treatment of industrial water and wastes; advanced consideration of industrial waste problems of major industries; techniques of saline water conversions. 1 unit. Prerequisite: credit or registration in Civil Engineering 440 and 442, or consent of instructor. ENGELBRECHT, O'CONNOR.

445. **Water Quality and Pollution.** Water quality standards and criteria for various beneficial uses; transport mechanisms for pollution in surface streams and ground water; fate of pollution and pollution control. 1 unit. Prerequisite: Civil Engineering 250 and 251; Mathematics 345. EWING.

446. **Design of Water and Waste Treatment Plants.** A study of the fundamental factors affecting choice of treatment units and combination of unit processes into an integrated plant. 1 unit. Prerequisite: Civil Engineering 440, credit or registration in Civil Engineering 442, or consent of instructor. DICK, EWING.

447. **Radioactive Waste Disposal.** Same as Nuclear Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous wastes disposal; air monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282, or Chemistry or Nuclear Engineering 398, or consent of instructor. AUSTIN, EWING.

448. **Control of Air Pollution.** A study of air contaminants from all types of sources; deleterious effects of contaminants on plants, animals, and materials; determination of source strength; basic theory of control devices; air pollution surveys; and organization of control programs. 1 unit. Prerequisite: General Engineering 360. AUSTIN, PEARSON.

449. **Analysis of Air Pollutants.** Laboratory analysis of common air pollutants; theory of operation of laboratory and automatic field instrumentation. ½ or 1 unit. Prerequisite: Credit or registration in Civil Engineering 448. AUSTIN, PEARSON.

450. Advanced Hydrologic Analysis and Design. Hydrologic cycle; hydrometeorology; collection of data; hyetograph and hydrograph analyses; infiltration and evapotranspiration studies; groundwater exploration and recharge; statistical analyses; determination of waterway areas; flood routings; river and reservoir regulations; design and planning of flood control projects; and modern development such as radar weather, radioactive tracers, disposal of nuclear wastes, and electronic analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW.

452. Water Resources. An advanced interdisciplinary course on water resources planning and development; geographic aspects; data collection; governmental functions; hydrologic implications; river hydraulics; hydraulic physical units and water quality; economic aspects; legal, political, and social problems; case studies. 1 unit. Prerequisite: Consent of instructor. CHOW, STAFF.

456. Hydraulics of Surface Drainage. Applications of hydraulics and hydrologic principles; elements of channel design, hydrologic determination of design flow, hydraulics of culverts and bridge openings, overland flow, flow in gutters and inlets, and hydrologic and hydraulic design of a bridge opening or culvert system. 1 unit. Prerequisite: Theoretical and Applied Mechanics 235. MURTHA.

457. Ground Water. An advanced interdisciplinary course on ground water; hydrogeology; hydrodynamics of flow through porous media; ground water hydrology; hydraulics of wells; hydraulic analysis of seepage; ground water pollution; ground water resources. 1 unit. Prerequisite: Consent of instructor. CHOW, HOLLEY.

458. Open-Channel Hydraulics. Basic hydromechanics; flow types; channel characteristics; flow-profile computations; hydraulic jump analysis; design of nonerodible, erodible, and grassed channels and transitional structures; study of supercritical flow and unsteady flow; modern developments in theory and design practice; application of numerical method, method of characteristics, method of singular point, and electronic digital computers and analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW, MURTHA.

460. Structural Analysis. Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quantitative influence lines. 1 unit. Prerequisite: Bachelor of Science in engineering with a course in theory of simple structures. GAYLORD, HALTIWANGER.

461. Structural Theory and Design. Advanced structural theory from the standpoint of design, analysis, and behavior, with particular emphasis on analysis; evaluation of methods of elastic analysis of structures; limit design and analysis; continuous beams and frames; multiple-story structures; space frames; arches. 1 unit. Prerequisite: Bachelor of Science in civil engineering; Civil Engineering 361 or 460, or equivalent. FENVES, HALL, STALLMEYER.

462. Structural Theory and Design. Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long span roofs. 1 unit. Prerequisite: Bachelor of Science in civil engineering; Civil Engineering 361 or 460, or equivalent. MOSBORG, STALLMEYER.

465. Structural Design in Metals. Theories of behavior of structural metal members and their components; interpretation of codes and specifications for the design of bridges and buildings. This course and Civil Engineering 475 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Bachelor of Science in engineering with courses in structures. GAYLORD.

467. Behavior of Reinforced Concrete Structures. Ultimate strength and behavior of statically indeterminate reinforced concrete structures; applicability of elastic analysis to framed structures; analysis and design of floor slabs in buildings. 1 unit. Prerequisite: Civil Engineering 366. SIESS.

470. **Statistical Theory of Structural Engineering.** Study of the concepts and applications of probability and statistical theory in structural engineering and research, with emphasis on the scientific principles for considering fluctuations and randomness in physical phenomena and processes; mathematical modeling in structural mechanics including Monte Carlo simulation in structural systems analysis and design; engineering decision-making under uncertainty; analysis of loads and resistances; safety analysis of structures including system reliability prediction; introduction to stochastic structural dynamics. 1 unit. Prerequisite: Consent of instructor. ANG.

471. **Numerical and Approximate Methods of Structural Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments and deflections of plates, other problems. 1 to 2 units. EUBANKS, MELIN, ROBINSON.

472. **Advanced Numerical Methods in Engineering.** Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures; blast, impact, and earthquake effects on structures; buckling and flexure of frameworks; torsion of solid and thinwalled sections; lateral buckling of beams; bending and buckling of plates and of stiffened plates; plane stress and axially symmetric problems in elasticity; other topics. 1 to 2 units. Prerequisite: Civil Engineering 471. ROBINSON, YANG.

473. **Analysis and Design of Plates and Shells.** Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highways and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs, and hipped plate construction. 1 and 2 units. Prerequisite: Consent of instructor. SCHNOBRICH.

474. **Behavior of Structures Under Dynamic Loads.** Free vibrations, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analytical methods for the effects of wind load, explosion blast, impact, earth tremors, and other time-dependent excitations; effects of damping and inelastic action; propagation of stress waves; wind-induced vibrations with application to cables, pipelines, and tall stacks. 1 to 2 units. Prerequisite: Consent of instructor. WALKER.

475. **Behavior of Steel Structures.** A critical evaluation of the actual behavior of metals, connections, members, and structures; the significance of this behavior in terms of design and the development of design specifications. This course and Civil Engineering 465 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Graduate standing in civil engineering or theoretical and applied mechanics. MUNSE.

476. **Plastic Analysis and Design.** Inelastic behavior of metal structural frameworks; concept of the plastic hinge; collapse configurations; analysis of collapse mechanisms; requirements for stability; deflections, incremental collapse, shakedown; connections; optimum design; grid frameworks. 1 unit. Prerequisite: Civil Engineering 465 or consent of instructor. GAYLORD.

477. **Design of Structures for Dynamic Loads.** Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast-

resistant structures; criteria for design of earthquake-resistant structures; application to actual problems. 1 unit. Prerequisite: Consent of instructor. HALTIWANGER.

478. **Matrix Theory of Structural Mechanics.** Fundamental concepts of matrix calculus and its applications for a unified treatment of advanced structural mechanics and dynamics; basic calculus of matrices; iterative solution of systems of algebraic and differential equations; stress and structural analysis, method of tearing tensors; discrete simulation of continuous systems in higher dimensions; eigenvalue problems of discrete systems. 1 unit. Prerequisite: Civil Engineering 461 or 471, or consent of instructor. ANG.

479. **Applied Structural Mechanics.** Study of beams under lateral load; beams with combined lateral load and thrust; buckling; beams on elastic foundations; applications of Fourier series and virtual work principles to beam-type structures; stress and strain in three dimensions; applications to flexure of beams and plates and to constrained torsion; elements of the engineering theory of plates. 1 unit. Prerequisite: Mathematics 345 and one undergraduate course in statically indeterminate structures, or consent of instructor. PAUL, ROBINSON.

480. **Earth Pressures and Retaining Structures.** Classical and modern earth pressure theories and their experimental justification; pressures and bases for design of retaining walls, bracing of open cuts, anchored bulkheads, cofferdams, tunnels, and culverts. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384. IRELAND, PECK.

481. **Earth Dams and Related Problems.** Fundamentals of problems of slope stability; seepage in composite sections and anisotropic materials; methods of stability analysis; mechanism of failure of natural and artificial slopes; compaction; field observations. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384, or consent of instructor. PECK.

482. **Measurement of Soil Properties.** Laboratory and field work in soil sampling, classification, and testing; experimental studies of modern soil mechanics parameters and theories with emphasis on applications to design problems. Experiments include permeability, consolidation, direct shear, and triaxial shear. The research approach is used to point out interpretations and limitations of data in practice. 1 unit. Prerequisite: Credit or registration in Civil Engineering 383, or consent of instructor. OLSON.

483. **Soil Mechanics.** Advanced studies of research techniques in soil mechanics and foundation engineering. 1 unit. Prerequisite: Civil Engineering 384 or consent of instructor. OLSON.

484. **Foundation Engineering.** Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. 1 unit. Prerequisite: Civil Engineering 384. IRELAND, PECK.

485. **Soil Engineering for Transportation Facilities.** Problems of soil classification; evaluation of stability of natural and compacted soils as subgrades, slopes, and embankments; effect of climate, soil properties, compaction, and admixtures on subgrade stability. 1 unit. Prerequisite: Civil Engineering 383 or equivalent. LIU, THORNBURN.

492. **Measurement Theory and Experimental Design.** The principles of engineering experimentation from both a classical and a statistical point of view. Nature of experimental error; test planning; data analysis; special techniques. Examples within the civil engineering discipline are emphasized. 1 unit. Prerequisite: Mathematics 263 or equivalent. CHILTON.

494. **Municipal Administration and Engineering.** Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and

zoning; building codes and inspection; street lighting; public utilities; city cleaning; recreational development. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. DANNER.

495. **Civil and Sanitary Engineering Seminar.** Discussion of current topics in civil and sanitary engineering and related fields by staff, students, and visiting lecturers. Course may be repeated. 0 or ¼ unit.

497. **Special Problems.** Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the investigation. 0 to 4 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Surveying.** Precise horizontal and vertical control surveys; state plane coordinate systems; special construction surveys. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

302. **Photogrammetric Engineering.** A study of metrical photography in civil engineering practice; characteristics and interpretation of aerial and terrestrial photographs; stereoscopic compilation of maps from photographs; mosaics; economics of photogrammetry; map reproduction. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

303. **Property Location Surveys.** Original, retracement, and subdivisional surveys in relation to real property. ½ or 1 unit. Prerequisite: Civil Engineering 201 or consent of instructor.

305. **Observational Astronomy.** Same as Astronomy 314. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143.

314. **Fundamentals of Systems Approach.** Introduction to the application of linear programming, network theory, and queueing theory to the synthesis of civil engineering systems. ½ or 1 unit. Prerequisite: Civil Engineering 215; Mathematics 263 or consent of instructor.

315. **Construction Productivity.** Introduction to the application of scientific principles to the measurement of and the forecasting of productivity in construction engineering; conceptual and mathematical formulations of the labor, equipment, and material factors affecting productivity. ½ or 1 unit. Prerequisite: Civil Engineering 215; credit or registration in Mathematics 263 or equivalent; or consent of instructor.

316. **Construction Planning.** Introduction to the application of scientific principles to the normative planning of construction operations. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

318. **Construction Cost Analyses and Estimates.** Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts of and statistical measurements of the factors involved in direct costs, general overhead costs, cost mark-ups and profits; the fundamentals of cost recording for construction cost accounts and cost controls. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

321. **Bituminous Materials and Mix Design.** Properties and control testing of bituminous materials; analysis of bituminous paving mixtures; composition and design of asphaltic concrete and soil-asphalt mixes. ½ unit. Prerequisite: Civil Engineering 214 and 220, or consent of instructor.

322. **Development of Highway Facilities.** Analysis of factors in developing a highway transportation facility; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; highway maintenance planning. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

325. **Highway Traffic Characteristics.** Vehicle operating characteristics; driver characteristics; pedestrian characteristics; roadway characteristics as they individually, and collectively as traffic stream characteristics, are related to the planning, design, and operation of highway facilities. ½ unit. Prerequisite: Civil Engineering 220 or consent of instructor.

333. **Urban and Regional Transportation.** Importance of transportation and its relation to urban and regional planning; characteristics of transport systems; transportation planning including surveys, data analysis, and problems of administration and finance; coordination and integration of transport. ½ or 1 unit. Prerequisite: Consent of instructor.

334. **Airport Design.** Basic principles of site selection for airports and fundamental considerations of design, construction, and maintenance of airport pavements and structures. ½ or 1 unit. Prerequisite: Civil Engineering 220 and senior standing in civil engineering, or consent of instructor.

335. **Railway Construction and Maintenance.** Loads and load distribution on track and subgrade; roadbed construction and stabilization; track stresses, design, and materials; turnouts and crossings; maintenance programs. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

336. **Railway Location and Operation.** Influence of traffic, alignment, distance, gradients, and motive power upon operating expenses; mechanics of train operation; economic design of location. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

337. **Signals.** Train movements; systems of signals; track circuits; track capacity; interlockings; economics of signaling. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

338. **Terminals.** Design and operation of freight terminal facilities for rail, highway, air, and water carriers; passenger terminals; special terminal requirements for specific commodity categories; coordination. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

345. **Environmental Health Engineering.** The application of engineering principles to the control of environmental sanitation and communicable disease control, including administration, biostatistics, epidemiology, vector control, pesticides, milk and food sanitation, swimming pools, individual water supply and wastewater disposal, plumbing, refuse collection and disposal, industrial hygiene and air pollution, radiological health and international health. ¾ unit. Prerequisite: Consent of instructor.

346. **Biology of Polluted Water.** The significance of biology in water quality, stream pollution, and waste treatment. ½ unit. Prerequisite: Consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Nuclear Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry; sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Nuclear Engineering 397 or Physics 382, or equivalent.

351. **Hydromechanics.** Applied fluid mechanics with particular reference to topics in hydraulic design, analysis, and research in civil engineering areas; covers dimensional analysis and dynamic similarity, analysis of potential flow, boundary-layer problems, turbulence and diffusion. Hydraulic transients, water waves, transport phenomena. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 251.

352. **Water Resources Design.** Study and evaluation of phases of river mechanics; water resources history and project implementation; development of a water resources project plan. ¾ unit. Prerequisite: Civil Engineering 250; Theoretical and Applied Mechanics 235.

353. **Hydraulic Structures.** Introduction to the design of hydraulic structures, including consideration of types and function of dams; hydrologic design; hydraulic design of spillways and outlet works; determination of loads and stresses for concrete structures; seepage, piping, and stability of earth structures. ¾ unit. Prerequisite: Civil Engineering 250 and 251.

354. **Hydraulic Engineering Laboratory.** Fundamental principles, operation, and use of model laboratories; dimensional analysis; hydraulic similitude; theory and design of hydraulic models as applied to a specific laboratory problem. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235.

361. **Advanced Structural Analysis.** Numerical methods of structural analysis; general theory of continuity; prismatic and nonprismatic members; continuous framed structures; trussed structures; lateral load distribution; secondary stresses. ¾ or 1 unit. Prerequisite: Civil Engineering 262 or equivalent.

363. **Behavior and Design of Metal Structures, II.** Members under combined loads; welded, riveted, and bolted connections; moment-resistance connections; plastic design. ¾ or 1 unit. Prerequisite: Civil Engineering 263 or consent of instructor.

364. **Reinforced Concrete Design, II.** Limit design of continuous reinforced concrete members and slabs of various types. ¾ or 1 unit. Prerequisite: Civil Engineering 264; credit or registration in Civil Engineering 262.

366. **Behavior of Reinforced Concrete Members.** Ultimate strength and behavior of reinforced concrete members and relation between results of research and current specifications for design; members subjected to flexure, axial compression, combined flexure and axial load, combined flexure and shear, and bond. 1 unit. Prerequisite: Bachelor of Science in civil engineering or architecture with courses in structures and reinforced concrete design.

368. **Prestressed Concrete.** Principles and methods of linear prestressing; behavior, strength, and design of noncomposite simple beams, composite simple beams, and continuous beams; time-dependent variables and long-time deflections. ¾ or 1 unit. Prerequisite: Civil Engineering 262 and 264.

369. **Behavior and Design of Wood Structures.** Theory and practice in design of modern wood structures; effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. ¾ or 1 unit. Prerequisite: Civil Engineering 261 or equivalent, or consent of instructor.

380. **Foundation Engineering.** Evaluation of subsoil conditions as they affect the behavior, proportions, and choice of type of foundations; bearing capacity and settlement analyses; character of natural soil deposits; earth pressure theories and retaining wall analysis; slope stability. 1 unit. Prerequisite: Civil Engineering 210.

383. **Soil Mechanics.** Identification, description, and classification of soils; index properties, weight-volume relationships; hydraulic properties; stress-deformation characteristics; ultimate strength; subsurface exploration; character of natural soil deposits. ¾ or 1 unit. Prerequisite: Consent of instructor.

384. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; earth pressure and retaining walls; braced cuts; damage due to construction operations. ¾ or 1 unit. Prerequisite: Civil Engineering 383 or consent of instructor.

385. **Engineering Aspects of Surficial Soils.** Use of geologic and pedologic information and airphoto interpretation techniques in the prediction of engineering properties of soils and the planning of engineering soil surveys. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Civil Engineering 210 or consent of instructor.

391. **Numerical and Computer Applications in Civil Engineering.** Introduction to digital computers and their programming; development of methods for the efficient use of computers in the solution of design and other problems; description of applications; discussion of role of computers in performing engineering computations. ½ or 1 unit. Additional work required for more than ½ unit of graduate credit. Prerequisite: Graduate standing in civil or architectural engineering, or consent of instructor.

THE CLASSICS

The Department of Classics offers graduate work leading to the Master of Arts and Doctor of Philosophy.

The Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. In all cases, the requirement of a master's thesis is waived; extra units of work in Greek or Latin are substituted for the thesis.

The Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All graduate students should take Greek or Latin 495-496, Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a departmental brochure which may be obtained by applying to the head of the department, 360 Lincoln Hall.

At the beginning of each term, written examinations in the translation of Greek and Latin are scheduled. Candidates for the master's degree (or equivalent) must take one examination in their major language each term. Advanced students must take both the Greek and Latin examinations each term until the preliminary examination has been passed. Satisfactory performance in both languages is required before admission to the preliminary examination.

GRADUATE FACULTY

Professors: J. L. Heller (Head of Department), R. P. Oliver, A. Tovar, A. Turyn.

Associate Professor: J. J. Bateman.

Assistant Professors: M. R. Dilts, W. P. Donovan, W. C. Kurth, M. Naoumides.

Classical Civilization

The following courses presuppose no knowledge of the Greek or Latin language and are open to all students. For other courses in the area of classical civilization, see Art 311; History 381, 382, 383, and 384; and Philosophy 303 and 309.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Classical Literary Traditions, I.** Greek literature from Homer to Aristotle. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Bateman.

302. **Classical Literary Traditions, II.** Literary forms in the Alexandrian and Roman periods. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. BATEMAN.

318. **Elements of Technical Terminology.** Presentation and analysis of Greek and Latin prefixes, suffixes, and root-words basic in the vocabularies of modern science, especially botany, psychology, zoology, and medicine. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent, or completion of twenty hours of science or architecture. HELLER.

361. **The Archaeology of Greece.** Monuments and material remains illustrating the development of Greek civilization to 323 B.C. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. DONOVAN.

362. **The Archaeology of Italy.** Monuments and material remains illustrating the development of Graeco-Roman and other ancient Italian civilizations to 330 A.D. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. DONOVAN.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 360 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. **Greek Versification.** Greek prosody: survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. 1 unit. TURYN.

411. **Hellenistic Literature.** 1 unit. BATEMAN.

412. **Lucian and His Age.** 1 unit.

413. **Greek Lyric Poetry.** 1 unit. TURYN.

414. **Pindar.** 1 unit. TURYN.

415. **Homer.** 1 unit. BATEMAN.

416. **Thucydides.** 1 unit.

417. **Bacchylides.** 1 unit. TURYN.

422. **Sophocles.** 1 unit. TURYN.

423. **Aeschylus.** 1 unit. TURYN.

424. **Euripides.** 1 unit. TURYN.

425. **Greek Drama: Comedy.** 1 unit. TURYN.

491. **Directed Reading.** ½ unit. Prerequisite: Second-year graduate standing. NAOUMIDES.

495. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Latin 496. ½ unit. OLIVER.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, NAOUMIDES, OLIVER, TOVAR, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Comparative Grammar of Greek and Latin.** Same as Latin 308. A historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. TOVAR.

391. **Readings in Greek Literature.** Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen) : Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. ¾ unit. Prerequisite: Two years of college Greek; consent of instructor. STAFF.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. Two of the four required units in Latin must be in courses numbered above 400; the other two units are Latin 311, 312, and 391. The required work in education consists of Educational Psychology 311 and 312 and one unit selected from History and Philosophy of Education 303, 304, 305. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. L. Heller, 360 Lincoln Hall.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 360 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is four years of college Latin or equivalent.

401. **Readings in Latin for Graduate Students.** Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. No graduate credit. Prerequisite: Two years of high school Latin or equivalent. BATEMAN.

409. **History of the Latin Language.** 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language. TOVAR.

410. **Vulgar Latin.** 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language. TOVAR.

411. **Latin Epigraphy.** 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.

412. **Latin Elegy.** 1 unit. OLIVER.

413. **Caesar.** 1 unit. TURYN.

414. **Lucan.** 1 unit. OLIVER.

415. **Lucretius.** 1 unit. TOVAR.

416. **Vergil.** 1 unit. TURYN.

421. **Horace.** 1 unit. TURYN.

422. **Plautus and Terence.** 1 unit. TURYN.

423. **Latin Romance.** 1 unit. TOVAR.

425. **Cicero.** 1 unit. TURYN.

426. **Tacitus.** The *Annales*. 1 unit. OLIVER.

427. **Roman Satire.** 1 unit. BATEMAN.

441. **Latin Paleography.** 1 unit. OLIVER.

491. **Directed Reading.** ½ unit. Prerequisite: Second-year graduate standing. HELLER.

495. **Bibliography and Criticism.** Same as Greek 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Greek 496. ½ unit. OLIVER.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, NAOUMIDES, OLIVER, TOVAR, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Comparative Grammar of Greek and Latin.** Same as Greek 308. A historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. TOVAR.

311. **Advanced Latin Composition.** Practice in the writing of Latin prose. ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. OLIVER.

312. **Advanced Latin Composition.** ½ unit. Prerequisite: Latin 311. OLIVER.

313. **Oral Latin.** Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.

391. **Readings in Latin Literature.** Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations*, Seneca, Ovid, Cicero's *Essays*, Patristic Latin, Medieval Latin. ¾ unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

Doctor of Philosophy in Communications. This program is administered by the Committee on Graduate Study in Communications an interdepartmental committee of the Graduate College faculty. It provides a core program in communications and permits advanced specialization in several areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics.

The program applies the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communications. It is intended for students who plan careers in teaching communication subjects such as journalism, radio-television, and psycholinguistics; scholarly research on the development, control, and ethics of the mass media; experimental research on public opinion measurement; advertising, communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission is a 4.0 grade average and a broad background in the social sciences and humanities. Many of the advanced courses have introductory courses as prerequisites. An introductory course in statistics is generally useful.

A candidate for the Doctor of Philosophy in Communications must complete at least twenty-four units of graduate work. The program provides both an introduction to the broad field of communications with its related disciplines (requirements 1, 2, and 4, below), and specialization in a subfield (requirements 3 and 5). The student must meet these detailed requirements:

(1) Communications 471 and 472, Proseminar, two units.

(2) One unit selected from Group A (Communications 414, 432, 444, 462, 468, 470, 473, 474, 481, 483, 307, 308, 344, 360, 372), and one unit from Group B (Communications 420, 424, 425, 426, 451, 456, 325, 370).

(3) An area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics (illustrated by Group B above). Occasionally the Committee will approve other specializations. Two units must be taken in courses in research methods; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research. Courses for the area of specialization are not limited to courses cross-listed with communications. With his adviser's approval, a student may offer any relevant graduate course as part of the major.

(4) Either a sole minor of four units in a discipline other than communications, or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa*.) Courses cross-listed in communications may not be counted toward a minor in a discipline other than communications.

(5) Communications 499, Thesis Research, eight units.

(6) Language requirements of the Graduate College.

(7) A preliminary written and oral examination.

(8) A final oral examination centered on but not restricted to the field of the dissertation.

Minor. A candidate for the Doctor of Philosophy wishing to minor in communications should select four, three, or two units (according to the requirements of his major department). Communications 471 and 472 are recommended as giving a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background for the courses they choose.

Further information may be obtained from the chairman of the administrative committee, Professor Theodore Peterson, 119d Gregory Hall.

GRADUATE FACULTY

Professors: T. Peterson (Chairman of Committee on Graduate Study in Communications), J. B. Casagrande, C. B. Hagan, J. E. Hulett, J. W. Jensen, H. L. Mueller, C. E. Osgood, C. H. Sandage, H. J. Skornia, I. D. Steiner, R. E. Stevens, N. Wedding.

Associate Professors: M. E. Fishbein, L. Linsky, H. S. Maclay, C. J. McIntyre, J. E. Moyer, Rita J. Simon.

Assistant Professors: J. W. Carey, L. A. Jakobovits, J. L. Simon, Nancy Wiggins.

COURSES FOR GRADUATES

414. **Seminar on Social Interaction.** Same as Sociology 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

420. **Seminar in Semantics.** Same as Philosophy 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. Linsky.

424. **Linguistics and Communication.** Same as Linguistics 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. Maclay.

425. **Psycholinguistics.** Same as Linguistics and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory, and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. Osgood.

426. **Research Seminar in Psycholinguistics.** Same as Linguistics and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Communications 425; consent of instructor. Maclay, Osgood.

432. **History of Books and Printing.** Same as Library Science 432. The origin and evolution of the alphabet and of scripts; the history of manuscript books; the invention and spread of printing; the account of the production and distribution

of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. 1 unit. STEVENS.

435. **Fundamentals of Cybernetics.** Same as Biophysics 435 and Electrical Engineering 473. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 394 or Mathematics 361, or consent of instructor. ASHBY.

436. **Problems of Cybernetics.** Same as Biophysics 436 and Electrical Engineering 474. A continuation of Electrical Engineering 473. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Communications 435. ASHBY.

444. **Seminar in Public Opinion.** Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. R. J. SIMON.

451. **Advanced Social Psychology.** Same as Psychology 451. A systematic and critical treatment of individual behavior variables in relation to group variables. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 255 or equivalent. MCGRATH, STEINER.

456. **Psychology of Social Communication.** Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor. FISHBEIN.

462. **Seminar in Radio and Television.** Same as Radio-Television 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. SKORNIA.

468. **The Political Economy of Communications.** Same as Journalism 468. Analysis of the structure, policy, and behavior of such media of communications as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. GUBACK.

470. **Communications and Popular Culture.** Same as Journalism 470. problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit.

471. **Proseminar in Communications, I.** Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. 1 unit. CAREY, STAFF.

472. **Proseminar in Communications, II.** Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. MACLAY, STAFF.

473. **History and Theory of Freedom of the Press.** Same as Journalism 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. JENSEN.

474. **Communications Systems.** Same as Journalism 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. CAREY.

481. **Advanced Advertising Principles.** Same as Advertising 481. Emphasis is placed on determination and understanding of the principles as related to the science,

philosophy, and art of advertising. Students may not receive graduate credit for both Communications 481 and Advertising 388. 1 unit. WEDDING.

482. **Research Methods in Advertising and Communications.** Same as Advertising 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. J. L. SIMON.

483. **Advertising and the Mass Media.** Same as Advertising 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit. MOYER.

490. **Special Topics in Communications.** ½ to 2 units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications. STAFF.

492. **Research Methods in Communications.** Same as Journalism 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. WIGGINS.

499. **Thesis Research.** 0 to 4 units. Students may reregister for a total of eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **The Art of the Screen: Narration.** Same as Speech 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. **The Art of the Screen: Exposition and Persuasion.** Same as Speech 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

325. **Introduction to Psycholinguistics.** Same as Linguistics 325. An introductory survey of psychological and linguistic approaches to the study of communication. ½ or 1 unit. Prerequisite: An introductory course in linguistics or psychology. MACLAY.

344. **Public Opinion.** Same as Sociology 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100, or 104 and 105, Division of General Studies 151 and 152. R. J. SIMON.

360. **Educational Uses of Television and Radio.** Same as Educational Psychology and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

370. **Language, Culture, and Society.** Same as Anthropology and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

372. **Social Aspects of Mass Communications.** Same as Journalism and Sociolgy 372. Media structures related to cultural content and functions. Problems of life and society as treated in mass-produced communications. ½ unit. GUBACK.

COMPARATIVE LITERATURE

The program leading to the Master of Arts and Doctor of Philosophy degrees in Comparative Literature is designed to make possible a systematic study of subjects and problems common to several literatures. Its purpose is to enable students who have greater than average linguistic competence and preparation to explore (1) the interrelations of several literatures; (2) the main currents, periods, and movements in literary history; and (3) the theory of literature and criticism. The program is supervised by a committee made up of the heads and chairmen of the classical and modern language and literature departments. The student's program of study is supervised by an adviser in the department of his major interest. A student entering the program should have majored in one of the above mentioned departments as an undergraduate, have attained an undergraduate grade average of 4.0, and must present evidence of having acquired a command of two modern foreign languages. Some knowledge of Latin (or Greek) is highly recommended: Latin is necessary for students planning to specialize in the Medieval or Renaissance periods.

Master of Arts. A candidate for the Master of Arts in Comparative Literature must offer four units of credit in one literature, Comparative Literature 401, and two units of credit in a second literature. The courses chosen from the second language and literature department must be approved by the adviser; and at least four of the courses, in addition to Comparative Literature 401, must be chosen at the 400 level. The candidate must also pass an examination based on a reading list and designed to test his knowledge of the literature of his main interest as well as his ability to interpret a literary or critical text. A master's thesis is not required, although the student may elect to offer one with the approval of his adviser.

Doctor of Philosophy. A candidate for the Doctor of Philosophy in Comparative Literature must fulfill the general requirements of the Graduate College including those specified above for the master's degree. He must take at least four units of work in Comparative Literature 451 and 461. Four additional units of work at the 400 level are to be taken in courses regularly offered by the language and literature departments. The candidate will be responsible for a knowledge of the history of the literature in one modern language. He must also select a period of major interest, and will be responsible for a knowledge of two other literatures in this period, which will be considered as minors. The periods may be either (1) Medieval, (2) Renaissance, (3) Neo-Classicism and the Enlightenment, or (4) The Modern Period. He must pass a preliminary examination (a three-part written examination, plus an oral examination), and present a thesis in which he has investigated a topic with ramifications of a comparative nature.

Inquiries concerning the program should be addressed to Professor François Jost, Director of the Graduate Program in Comparative Literature, 244 Lincoln Hall.

COURSES FOR GRADUATES

401. **Theory of Literature.** The methods and objectives of the discipline of comparative literature. 1 unit. Prerequisite: Reading knowledge of two modern foreign languages; consent of instructor. JOST.

451. **Seminar in Literary Movements.** An investigation of the development and mutation of literary movements (classicism, romanticism, symbolism, etc.) through a study of critical texts and their reception in various countries. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit. Prerequisite: Comparative Literature 401. BLOCK, R. HUBERT, JOST, MITCHELL.

461. **Seminar in Literary Forms and Types.** A study of a form (the lyric, the novel, etc.) or a type (the romantic hero, the Faust myth, tragedy, satire, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it

may be taken more than once for a total of three units. 1 unit. BATEMAN, BLOCK, KNUST.

493. Special Studies. 1 unit.

499. Thesis Research. Intended for students engaged in writing a thesis as a partial requirement for the A.M. or Ph.D. degree in Comparative Literature. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

See Humanities, page 197.

COMPUTER SCIENCE

The Department of Computer Science offers instruction in courses and the supervision of theses for individuals specializing in the design and use of digital computing machinery. The department operates an IBM 7094-1401 computing system for general University use in research and instruction. Presently active areas of research include numerical analysis, Monte Carlo methods, programming, algebras of switching circuits, direct coupled computer circuits using transistors, high-speed memories, pattern recognition, and logical design of computers. In addition, the department has constructed a very high-speed computer of its own design (Illiac II). At present this computer is being augmented with a flexible complement of input-output equipment including the possibility of remote consoles. The department is also engaged in the design and construction of a general purpose pattern recognition computer (Illiac III). This expansion of facilities is intended in part to meet the expanding needs of the University and of the department in the area of data processing and scientific computation.

Members of the staff who are engaged in computer research regularly offer nineteen courses: Mathematics 195, 295, 387, 395, 397, 457, 458, 488, 489; Mathematics or Electrical Engineering 294, 385, 391, 392, 393, 394, 485, 487, 497, 498. There is also a weekly colloquium (no credit).

Although no advanced degree is offered by the Department of Computer Science, candidates for advanced degrees in electrical engineering, mathematics, or physics who are interested in this area of study may engage in thesis work under the supervision of one of the staff members of the department. Requests for additional information concerning the work of the department and applications for assistantships should be directed to the head of the Department of Computer Science.

GRADUATE FACULTY

Professors: J. R. PASTA (Head of Department), J. N. SNYDER (Associate Head of Department), L. D. FOSDICK, D. B. GILLIES, B. H. MCCORMICK, S. MUROGA, W. J. POPPELBAUM, J. E. ROBERTSON, D. L. SLOTNICK.

Associate Professors: C. W. GEAR, N. T. HAMILTON, T. A. MURRELL.

Assistant Professor: S. R. RAY.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology and microbiology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.75

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. Candidates for the Master of Science must complete one-half unit of seminar and two units of thesis research. For the Doctor of Philosophy, one and

eight units, respectively, of these courses are required. Other course requirements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the Master of Science are expected to complete an acceptable thesis unless the Dean of the Graduate College waives this requirement. All students expecting to continue graduate studies should fulfill the thesis requirements for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science also is required.

For a minor in dairy science, students should select an adviser in this area of study to determine the specific courses required. For the Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science, of which two units must be in 400-level courses; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

GRADUATE FACULTY

Professors: G. W. Salisbury (Head of Department), H. P. Broquist, R. E. Brown, K. E. Harshbarger, K. A. Kendall, R. W. Touchberry.

Associate Professors: M. P. Bryant, J. H. Byers, C. L. Davis, R. L. Hays, B. L. Larson, J. R. Lodge, M. J. Wolin.

Assistant Professors: J. C. DeFries, C. N. Graves.

COURSES FOR GRADUATES

402. **The Microbiology and Physiology of Ruminant Nutrition.** The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. ¾ unit. Prerequisite: Chemistry 350, 355, or equivalent. Brown, Bryant.

408. **Physiology of Lactation.** The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. ½ to 2 units. Hays.

411. **Population Genetics and Animal Breeding.** Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. Touchberry.

412. **Advanced Endocrinology.** Same as Animal Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. This course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. Gorski, Nalbandov.

430. **Physiology of Mammalian Germ Cells.** A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. Lodge, Salisbury.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Forestry, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. Carmer.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Forestry, Horticulture, and Veterinary Medical Science 441. A continuation of Dairy Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Dairy Science 440 or equivalent. CARMER.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. ½ to 2 units. Prerequisite: Ten hours of advanced microbiology and/or chemistry; consent of instructor. BRYANT, WOLIN.

490. **Dairy Science Seminar.** Current literature relating to various phases of dairy science. ½ unit. Prerequisite: Graduate major or minor in dairy science. SALISBURY.

493. **Special Problems.** Individual investigations in any phase of dairy science. ½ to 2 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, DEFRIES, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

499. **Thesis Research.** 0 to 4 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, DEFRIES, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** Supervised research on any phase of dairy science, including bacteriology and microbiology, biochemistry, feeding and nutrition, genetics, and physiology. ½ or 1 unit. Prerequisite: Approval of head of department. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, DEFRIES, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

305. **Genetics and Animal Improvement.** Same as Animal Science 305. The principles of heredity and their application to the problem of animal improvement. ¾ unit (Summer Session, ½ unit). Prerequisite: Dairy Science 110 or equivalent. DEFRIES, RASMUSEN, TOUCHBERRY.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. GRAVES, LODGE.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or Marketing 101 or twelve hours of dairy science or dairy technology. BARTLETT.

381. **Dairy Biochemical Laboratory Methods.** Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, microrespiration, and others. 1 unit. Prerequisite: Quantitative analysis; organic chemistry; consent of instructor. Biochemistry is recommended. BROQUIST, LARSON.

DANCE

The Dance Division offers a program of graduate study leading to the Master of Arts in Dance. This program offers advanced work in choreography, dance production, and pedagogy, with emphasis on the related fields of art, music, and theatre, and is administered by the supervisor of the Dance Division and an interdisciplinary committee composed of representatives from the Department of Art, the Department of Speech and Theatre, and the School of Music.

Admission requirements for a major in this field are: (1) a minimum grade-point average of 3.5; (2) twenty-four semester hours of approved undergraduate credit in dance (at least eight hours), art, music, theatre, and physical education; (3) thirty-

six semester hours in humanities (literature, language, and philosophy), natural sciences (biological and physical sciences), and social sciences (history, political science, psychology, anthropology, sociology, education). Applicants lacking a portion of the prerequisites under item (2) may substitute certified experience in dance not to exceed eight semester hours.

Satisfaction of the general requirements for admission to the Graduate College and to this program does not in itself necessarily qualify the student as a degree candidate. The supervisor of the Dance Division also reserves the right to accept for advanced study only those students whose preparation in dance has been obtained in certain approved institutions.

Of the eight units required for the Master of Arts, a minimum of four must be in dance, or (subject to the approval of the supervisor) in dance and related areas such as art, music, theatre, speech, physical education, and recreation; two units must be in one or more of the following fields: English, history, philosophy, anthropology, psychology, sociology, radio-television. The remaining two units are for the presentation of an acceptable thesis (Dance 499) and the accompanying noncredit course, Dance 490, Seminar. The thesis may be waived, with the approval of the adviser, but in lieu thereof the candidate must submit two units of course work (total of eight units), plus a recital of solo and group dances which he has choreographed and staged.

Not later than midpoint in the student's program, his work is reviewed in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The supervisor of the Dance Division may extend the residence requirement (or increase the total requirements) at this time or any other time, if this seems warranted.

GRADUATE FACULTY

Professor: Margaret Erlanger (Supervisor of Dance Division).
Assistant Professor: W. W. Ward, Jr.

COURSES FOR GRADUATES

400. **Problems in Dance Education.** Basic historical, philosophical, and scientific foundations and developments in dance education; teaching methods; development of compositional problems; creative methods of instruction; organizational problems of dance groups and public dance performance. 1 unit. Prerequisite: Dance 243 or 244, or equivalent. Erlanger.

401. **Choreography.** Experience in choreographing a minimum of one solo and one group composition to be presented at the end of the semester. ½ to 2 units. Prerequisite: Dance 345 or equivalent. Students may reregister for a maximum of two units with the permission of the supervisor of the Dance Division. Ward.

490. **Dance Seminar.** Student presentation of thesis reports in dance; informal discussions, demonstrations, lectures, and critical analysis of current problems in dance by professional guests. No credit. Staff.

499. **Thesis Research.** Preparation of theses in dance. ½ to 2 units. Erlanger.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **History of Dance.** A survey course tracing dance from its beginnings in primitive societies to its present art form. ½ unit. Prerequisite: Consent of instructor. Erlanger.

345. **Dance Production Workshop.** Experience in choreography and production of group compositions with special emphasis on staging, lighting, and costuming. ½ unit. Prerequisite: Dance 164 or equivalent; consent of instructor. Ward.

346. **Theory and Philosophy of Dance.** A study of the relationship of aesthetic principles and dance theory to a philosophy of dance in education and of dance as a performing art. ½ unit. Prerequisite: Consent of instructor. Erlanger.

ECONOMICS

The Department of Economics offers graduate work leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

A student who applies for admission to graduate study in economics must have a grade-point average of 4.0 or higher. Students with averages between 3.75 and 4.0 are considered on an individual basis. Applicants must have completed fifteen hours of undergraduate work in economics or have approval of the Director of Graduate Studies. The department requires that the results of the Graduate Record Examination Aptitude Test accompany application for admission to the Graduate College. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

The candidate for an advanced degree in economics may specialize in one of the following areas of economics: economic theory, history of economic thought, income theory and policy, monetary theory and policy, public finance and taxation, growth and development economics, international economics, mathematical economics, labor economics, economic history, comparative economic systems, economic statistics and forecasting, transportation, econometrics, operations analysis, economic education, and relations of government and business.

Master of Arts or Master of Science. The following requirements must be met:

(1) Economic Theory. Two units of course work, consisting of 400-401, or 402-403; if the student has had 300-301 or their equivalent, he must take 402-403.

(2) Statistics. Proficiency in statistical analysis. This requirement may be met by taking Economics 470 or by passing a proficiency examination.

(3) History of Economic Thought or Economic History. One unit in either field at the 400 level. Two units are recommended.

(4) Course work beyond that required to bring the total to eight units, two of which may be master's thesis work, or successful completion of the written qualifying examination for the doctorate.

Doctor of Philosophy. The following requirements must be met:

(1) Economic Theory. Economics 402-403, plus one additional 400-level course in economic theory.

(2) Statistics. The same demonstration of proficiency as for the master's degree.

(3) History of Economic Thought and Economic History. Passing a written preliminary examination in these subjects with one unit of 400-level course work in each.

(4) Specialized Fields. The student must select three additional fields, two of which must be in economics, and the third outside the department. At least two units of graduate work in courses in each field selected are required.

(5) Additional units to bring the total to twenty-four, of which eight must be doctoral dissertation units.

The candidate is required to pass examinations in two foreign languages, an oral and written preliminary examination prior to beginning dissertation research, and an oral final examination covering his research.

GRADUATE FACULTY

Professors: J. F. Due (Chairman of Department), V L. Bassie, R. Brandis, H. J. Brems, R. Ferber, D. P. Flanders, M. Frankel, R. W. Harbeson, D. R. Hodgman, D. L. Kemmerer, E. B. McNatt, W. H. McPherson, W. A. Neiswanger, D. W. Paden, J. B. Parrish, J. D. Phillips.

Associate Professors: Grace Beckett, R. W. Gillespie, F. M. Gottheil, W. W. McMahon, H. O. Nourse, R. W. Resek, P. Schran, F. R. Shupp, C. M. Sprenkle, S. W. Steinkamp, P. Wells, Janet L. Weston, T. A. Yancey.

Assistant Professors: D. J. Aigner, D. A. Markwalder, G. I. Weber.

COURSES FOR GRADUATES

400. **General Economic Theory.** Emphasis in this course is placed on micro-economic theory. The principal topics include: a review of value and distribution theory, the theory of choice by households and firms, general micro-economic theory, and theoretical developments of current interest. Attention is given to empirical studies intended to affirm or disaffirm economic principles. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. FLANDERS.

401. **General Economic Theory.** Emphasis in this course is placed on macro-economic theory and the relationship of economics to the other social sciences. The principle topics include: a review of Keynesian macro-economic theory, formal growth theory, selected business cycle theory, the theory of socio-economic change, and an outline of the differentiation and integration of economics and other social sciences. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. FLANDERS.

402. **Economic Theory.** This course develops modern micro-economic theory: utility functions and demand; production functions and cost; linear programming; price and nonprice policy by the firm; market equilibria; income distribution; general equilibrium including input-output analysis. The course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. STAFF.

403. **Economic Theory.** This course develops modern macro-economic theory; the Keynesian model of employment, interest, and money; its extension to international trade; fiscal policy and macro-economic theory of distribution; the consumption function; the theory of growth and cycles in terms of difference and differential equations. This course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. STAFF.

406. **History of Economic Thought.** A study of the origins and development of economic thought from early times to mid-nineteenth century. Factors are considered that aid in the growth of states and the subsequent policies of mercantilism and physiocracy. Classical economics and economists are emphasized. 1 unit. STAFF.

407. **History of Economic Thought.** The study begins with Socialist doctrines and covers the development of marginal utility, neoclassical, and Keynesian analyses and more recent contributions to economic thought. 1 unit. STAFF.

410. **Price and Distribution Theory.** A research-oriented seminar in micro-economic theory. Major topics treated include: comparative static analysis of demand, production, and the theory of markets; dynamic equilibrium; market dynamics. Sub-topics include axiomatics of preferences; ordinal and Bernoullian utility, revealed preference, and the interdependence of preferences; multiperiod production, utility, and consumption; the aggregation of micro-economic relationships; expectations and response lags; analysis of changing market structures; game theory. 1 unit. Prerequisite: Economics 402 and 470, or equivalent. AIGNER.

411. **Capital and Interest Theory.** A comprehensive and critical examination of the theory of capital and interest as the subject has been developed by the leading English and continental writers. Special attention is given to the optimal investment decision of the firm, capital accumulation and the efficient utilization of society's resources, and to the relation between capital and interest. 1 unit. Prerequisite: Economics 403 or consent of instructor. WELLS.

412. **Advanced Aggregate Income Theory.** An analysis of the theory of income and employment with emphasis upon the measurement of income and product, money flows, and the relationship between input and output in the economy. 1 unit. Prerequisite: Economics 403 or consent of instructor.

413. **Consumption Theory.** The theory of consumer behavior in modern economic analysis. Utility analysis at the micro level, consumer interdependence and problems of aggregation, econometric tests, aggregate consumption analysis in static and dynamic contexts, and the implications of the theory of consumer behavior for cyclical movements and economic growth. 1 unit. Prerequisite: Economics 400 or 402, or consent of instructor. FERBER, MCMAHON.

414. **Public Finance.** Analysis of government expenditures and decision making; the budgetary process; fiscal policy; government borrowing and debt management; intergovernmental fiscal relations; pricing of government services; public finance in developing economies. 1 unit. Prerequisite: Six hours of economics. DUE.

415. **Economics of Taxation.** Principles of taxation; incidence and distribution of tax burden; economic analysis of the major taxes: the personal and corporate income taxes, sales and excise taxes, property tax, and others; taxation and economic development. 1 unit. Prerequisite: Six hours of economics. DUE.

420. **Monetary Theory.** A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the quantity theory, liquidity preference, the demand for money, velocity, theories of the level and term structure of interest rates, asset theory, and money in static and dynamic macro-general equilibrium models. 1 unit. Prerequisite: A course in income and employment theory or consent of instructor. HODGMAN, SPRENKLE.

421. **The Theory of Monetary Policy.** Theories of central banking, debt management, financial intermediaries, and the monetary behavior of firms and households are used to explore current issues in the theory of monetary policy. Current empirical research is reviewed with particular emphasis on econometric studies of monetary behavior. 1 unit. Prerequisite: A course in money and banking, in macroeconomic theory, calculus, and statistics, or consent of instructor. HODGMAN, SPRENKLE.

425. **Macro-Accounting.** Same as Accountancy 455. An examination of the fundamental concepts underlying the attempt to measure the economic activities of macrounits; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor.

428. **International Trade Theory.** The neoclassical theory of international trade is developed and then used for the analysis of tariffs, customs, unions, and the effects of trade on the distribution of income and welfare. The relations between the balance of payments and national income are analyzed and used to study the role of income changes combined with price changes in the balance of payments adjustment process. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. GILLESPIE.

429. **International Trade Policy.** Concepts of balance of payments equilibrium, the foreign exchange market and the theory of capital movements; current problems and policies related to balance of payments desequilibrium, trade policy, and the functioning of the international monetary system. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. GILLESPIE.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, foreign and domestic commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 236. 1 unit. KEMMERER.

438. **Economic History of Europe.** The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, and industrialization, etc. 1 unit. Prerequisite: Consent of instructor.

440. **Labor Economics.** Same as Labor and Industrial Relation 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics. McNatt.

441. **Labor Economics.** Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy) . Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics. McNatt.

442. **Collective Bargaining.** Same as Labor and Industrial Relations 442. The development of a theory of the continuing interactions between unions and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and governmental process. 1 unit. Prerequisite Consent of instructor.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Labor and Industrial Relations 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling, analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. McPherson.

444. **Economics of Manpower Resources.** Same as Labor and Industrial Relations 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar. Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. Parrish.

447. **Labor Union Organization and Administration.** Same as Labor and Industrial Relations 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. Garman.

450. **The Economics of Development and Growth.** Review and analysis of the theories and patterns of growth in developed and underdeveloped economies. The problems and methods of measuring growth are considered, the variables thought to be strategic in the growth process are critically examined, and the policy implications of different theories are explored. 1 unit. Prerequisite: Economics 300 and 301, or consent of instructor. Frankel, Harris.

451. **The Developing Economies.** An analysis of the newly-developing economies, with emphasis on institutional factors affecting development, and economic policy relating to development. 1 unit. Prerequisite: Economics 300 or consent of instructor. Economics 450 recommended. Staff.

455. **Comparative Economic Systems.** A comparative analysis of the structures and policies of market-directed and planned economies. 1 unit. Prerequisite: Economics 103 or 108 or equivalent. GOTTHEIL.

467. **Economic Activity Analysis.** Selected topics in economic theory are analyzed with the aid of mathematical programming, input-output analysis, set theory, and game theory. Existence, optimality and stability conditions for static and dynamic general equilibrium phenomena are emphasized, and such related topics as welfare economics and capital accumulation may be treated. 1 unit. Prerequisite: Consent of instructor. BREMS.

468. **Economic Dynamics.** The course is devoted to the study of the behavior of aggregate output and income over time. Mathematical models are developed of long-run growth and short-run cycles, as well as the interactions between the two. Familiarity with first-order, second-order, and higher order single difference equations as well as systems of difference equations is acquired in the course. 1 unit. Prerequisite: Economics 403. BREMS.

470. **Economic Statistics.** Classical statistics and regression analysis; descriptive statistics, probability, point and interval estimation, decision theory, variance analysis, linear regression and least squares estimates. 1 unit. Prerequisite: Consent of instructor. NEISWANGER.

471. **Economic Statistics.** Part 1: The construction of econometric models; characteristics of models and choice of estimating methods; estimates of parameters by various methods. Part 2: Bayesian statistics and decision theory. 1 unit. Prerequisite: Economics 470 or equivalent. NEISWANGER, YANCEY.

472. **Econometrics.** Same as Mathematics 472. Point estimates of parameters for systems of simultaneous equations; properties of various estimators; hypothesis testing and confidence intervals for econometric models. 1 unit. Prerequisite: Mathematics 363 and 315 or consent of instructor. RESEK, YANCEY.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information, selecting critical factors, and appraising the validity of analytical techniques. 1 unit. Prerequisite: Economics 170 and 312 or 373 or equivalents. BASSIE.

474. **Operations Research.** A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, dynamic programming, queueing theory, renewal theory, and simulation methods are applied to economic control systems with special emphasis on the problems of the firm. 1 unit. Prerequisite: Mathematics 363 and Economics 374 or equivalent. AIGNER, SHUPP.

479. **Research Seminar in Quantitative Economics.** Significant work in the area of quantitative economics is reported and explored by members of the instructional staff, by guest speakers from academic, governmental, and industrial centers, and by graduate students in the second year of their work who are assigned projects. 1 unit. Prerequisite: The equivalent of one year of graduate statistics (theoretical or applied), calculus, and the equivalent of one year of mathematical economics. FERBER.

480. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit.

481. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

490. **Individual Study and Research.** Directed reading and research. ½ to 1 unit. STAFF.

499. **Thesis Research.** Required of all students writing master's and doctor's theses in economics. 0 to 4 units. Master's theses, FLANDERS; doctor's theses, FRANKEL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Intermediate Micro-Economic Theory.** Micro-economic analysis including value and distribution theory. Topics include the analysis of demand, the theory of the firm and the industry, and the analysis of the pricing of the factors of production. Each topic is integrated in a micro-general equilibrium context which builds towards explaining the resource allocation process. ½ unit. Prerequisite: Economics 103 or 108. Students may not receive credit for both Economics 200 and 300. STAFF.

301. **Intermediate Macro-Economic Theory.** The modern theory of the determination of the level and rate of growth of income, employment, output, and the price level. Alternate fiscal and monetary policies to facilitate full employment and economic growth are discussed. Prerequisite: Economics 103 or 108. ½ unit. STAFF.

302. **Economic Analysis.** An introduction to the theory of income and employment, price and allocation, and instability and growth. S; ½ or 1 unit. Prerequisite: Economics 103 or 108, enrollment in National Science Foundation Summer Institute in Economics, or consent of instructor. PADEN.

306. **History of Economic Thought.** A study of the development of economics. Contributions of schools of thought and individual writers are examined in their settings and as they influenced economic thought and national policy. ½ unit. Prerequisite: Economics 103 or 108.

312. **Economic Dynamics and Growth.** An analysis of the causes of economic instability; the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. ½ or 1 unit. Prerequisite: Economics 108, or 103 and 301.

313. **Economics of Consumption.** Same as Home Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

329. **International Trade Policy.** Analysis of the trade policies of selected countries, with particular reference to the United States; study of the relationships between international trade policy and the theory of international trade and finance. ½ or 1 unit. Prerequisite: Economics 103 or 108. BECKETT.

335. **American Financial History.** American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banking and of other financial institutions, and the financing of government, especially of major wars. ½ or 1 unit. Prerequisite: Finance 250. KEMMERER.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history.

342. **Economics of Social Security.** Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108. MCNATT.

343. **Collective Bargaining.** Emergence of collective bargaining in American industry, national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. ½ or 1 unit. Prerequisite: Economics 240. PARRISH.

344. **The Law and Labor.** Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240. MCNATT.

349. **Senior Seminar in Labor Economics.** Pre-professional capstone course intended to unify other courses in labor economics and closely related fields. Included are studies of research techniques and sources; individual readings in current literature; preparation of research reports and papers; consideration of professional employment opportunities and graduate study in labor economics and industrial relations. ½ or 1 unit. Prerequisite: Economics 240 and consent of instructor. PARRISH.

352. **Economic Development in Latin America.** A study of economic activity and the process of diversification and industrialization in Latin America, with comparative analysis of selected countries. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. BECKETT.

353. **Economic Development in India and Southeast Asia.** Analysis of plans and progress toward economic development in India and Southeast Asia; economic characteristics of the area and their significance for economic development. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. CUMMINGS.

357. **The Soviet Economy.** Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. HODGMAN.

358. **The Economy of China.** Discussion of changes in the patterns of production, exchange, and distribution in Communist China, with emphasis on their relation to social transformation. Survey of Chinese economic history over the past century, dealing with the institutional background to and the structure of economic activities in China. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. SCHRAN.

360. **Regional Economic Development.** A survey of the theory and problems of regional economic development, including regional accounts, interregional income and trade theory, principles of the location of economic activity, theories of regional growth, and public policy for development of regions. ½ or 1 unit. Prerequisite: Economics 103 or 108. NOURSE.

366. **Mathematical Analysis in Economics.** This course is designed to acquaint the student with the application of mathematical techniques to economic theory, especially general equilibrium theory. ½ or 1 unit. Prerequisite: Economics 103 or 108; some knowledge of calculus.

371. **Sampling Theory and Technique.** Design of samples useful in economic and business research. Problems considered relate to the efficiency of sample designs, cost limitations, bias, non-sampling errors, and interpretation of results. Sampling theory is applied to specific sampling problems through the use of electronic computers. ½ or 1 unit. Prerequisite: Economics 173 or equivalent.

373. **National Income and Business Forecasting.** The development of the national income accounts and their use in forecasting business conditions. Forecasting for the economy as a whole and for the individual industry or firm. The construction and use of economic models in forecasting. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 173. NEISWANGER.

374. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of linear programming and dynamic programming, game theory, probability theory, queueing theory, and inventory theory. ½ or 1 unit. Prerequisite: Economics 170 and Industrial Administration 101, or consent of instructor.

384. **Economics of Transportation.** Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

386. **Current Transportation Problems.** An analytical and critical study of selected problems of current interest in transportation. ½ or 1 unit. Prerequisite: Economics 384. HARBESON.

389. **Industrial Competition and Monopoly.** The Organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

EDUCATION

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology (including a special program in psychology of classroom learning and instruction), elementary school teaching, early childhood education, teaching of reading, guidance and counseling (including rehabilitation counseling), history and philosophy of education, measurement and evaluation, research methods, school psychology, or any of the fields of secondary school education: English, home economics, industrial education, mathematics, modern languages, physical education, science, and social science.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher and undergraduate preparation appropriate to advanced study in the chosen major. Applicants who hold bachelor's degrees in fields other than teacher education are considered on an individual basis. See admission requirements for the Master of Education.

Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College (see pages 39 to 41), the following regulations apply to programs leading to the Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of not more than two units is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312 are required.

Doctor of Philosophy. The general requirements of the Graduate College pertaining to the Doctor of Philosophy must be met. (See pages 41-44.) To become a candidate for the Doctor of Philosophy with a major in education, the applicant must hold a master's degree with a major in education or some appropriately related subject. An applicant who has not written a master's thesis will be required to prepare and submit a paper equivalent to a master's thesis. The applicant should present credentials well in advance of his first registration. Required examinations and other steps preliminary to admission must be completed prior to the registration period. Admission is not complete until the student has been accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Applicants holding bachelor's degrees in fields other than teacher education may be considered individually for admission to the program leading to the Master of Education. Applicants admitted with deficiencies in professional education or for teacher certification will be required to take a limited number of undergraduate courses. Such courses will not be counted in the eight units of graduate work required for the Master of Education.

In general, the professional education requirements for the Master of Education and for teacher certification may be fulfilled through proficiency examination in Educational Psychology 211,. an appropriate methods course at the undergraduate level, student teaching, History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. However, an applicant admitted with deficiencies should expect to take additional courses in the teaching subject fields.

Those preparing for teaching at the secondary level must have completed a minimum of thirty-two semester hours of appropriate course work in the first teaching field, if elected, and from twenty to twenty-four semester hours of credit in a second teaching field. Previous course work in such fields will be evaluated and considered in determining the eligibility of a student for teacher certification.

Graduate students admitted with deficiencies for teaching in the elementary schools will be required to complete Illinois teacher certification requirements through appropriate undergraduate and graduate course work.

The advisers of students admitted with deficiencies will develop programs in which a maximum number of teacher certification requirements are met through courses also acceptable in fulfillment of master's degree requirements. Students admitted with no deficiencies can complete requirements for the Master of Education through full-time study in two semesters. However, students admitted with deficiencies for certification should anticipate from one to two additional semesters of course work.

Program. At least eight units of course work, including four units in education, are required. History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312 are required, except from students who pass proficiency examinations in these courses.

There may be one or two minors. In general, candidates for the Master of Education are expected to take at least two units in fields other than education, particularly if the specialization is in secondary education. One unit at the 300 level in the teaching subject (s) may be substituted for one of the three units at the 400 level otherwise required. Courses at the 200 level in the teaching subject (s) may be taken for graduate credit subject to the prior approval of the Dean of the Graduate College, but total credit in such courses may not exceed two units. Credit earned in such courses can not be applied to the requirements for the Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Residence. At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years' successful professional employment in education are required.

Program. A year of specialized professional study is required. Of the eight units of course work required, at least four must be in courses at the 400 level. Students who have not previously taken History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312, or equivalents, must take them or pass proficiency examinations. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education. The program must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy.

Residence. The residence requirement is similar to that for the Master of Education.

Doctor of Education. Programs leading to the Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Applicants for admission should present credentials well in advance of the date for their first registration. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Program. Sixteen units of course work beyond the master's degree are required. Extramural course work may not be included in this sixteen-unit requirement. (Exceptions may be made for Educational Psychology 413 and Educational Administration and Supervision 461, 462, and 463.) A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

History and Philosophy of Education 410 and Educational Psychology 415 and 496 are required (note prerequisites).

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission and must pass a comprehensive written examination before he may enter the oral preliminary examination.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

The thesis required for the Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the examinations, filing of thesis titles, and the preparation, submission, and publication of theses must be met.

Residence. Minimum residence requirements are (a) two consecutive semesters, at least three units each, or (b) one semester, at least three units, and the summer session immediately preceding or following, at least one and one-half units, plus an additional summer session, at least one and one-half units.

Doctor of Education in Art Education. Doctor of Education candidates whose major field of study is art education follow programs for which the College of Education and the Department of Art share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the Department of Art. For further information, see page 74.

Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 266.

SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an intern. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program are subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

SPECIAL EDUCATION

Graduate study in special education is available at the master's degree, advanced certificate, or doctoral levels. Master's degree programs require one to two years and are designed primarily to prepare teachers of the culturally deprived, deaf, emotionally disturbed, gifted, mentally retarded, and children with learning disabilities. The advanced certificate requires at least a year of study beyond the master's degree and emphasizes preparation for supervision and administration of programs of special education. Doctoral programs require three or more years of advanced graduate study and are designed to prepare administrators, college instructors, and researchers in the various fields of special education indicated above. Special admission requirements apply to all graduate programs in special education. Further information concerning programs, admission requirements, and financial assistance may be obtained from the Chairman of the Graduate Selection Committee, Department of Special Education, 210 Education Building.

CLASSROOM LEARNING AND INSTRUCTION

Students planning to specialize in research and/or collegiate instruction in the educational psychology of classroom learning and instruction may become candidates for either the Doctor of Philosophy or the Doctor of Education. Doctor of Philosophy candidates major in education and minor in psychology or take a split minor with psychology and a related area, such as communications, or a subject such as mathematics, chemistry, or social studies. The program of study for the doctorate degree requires a minimum of three years of graduate study, including six months of internship. After an applicant is admitted, his study program is subject to review by one of the advisers associated with the program. A required core program consists of Educational Psychology 412, 449, 490, 492, 496, 497, and Psychology 418 and an internship of six months' minimum duration. The doctoral dissertation is generally written in the area of the nature, conditions, and improvement of classroom learning and instruction.

GRADUATE FACULTY

Professors: R. N. Evans (Dean of College of Education), C. M. Allen, E. W. Anderson, J. M. Atkin, D. P. Ausubel, F. P. Barnes, M. Beberman, G. M. Blair, H. S. Broudy, R. W. Burnett, J. J. DeBoer, F. H. Finch, J. J. Gallagher, N. E. Gronlund, J. T. Hastings, S. P. Hencley, K. B. Henderson, D. M. Jackson, R. S. Jones, M. R. Karnes, W. V. Kaulfers, G. C. Kettelkamp, Colleen J. Kirk, S. A. Kirk, C. G. Knapp, A. H. Krebs, K. M. Lansing, L. E. McCleary, J. E. McGill, W. P. McLure, L. E. Metcalf, P. V. Miller, W. J. Moore, T. E. Newland, M. M. Ohlsen, C. H. Patterson, L. J. Phipps, R. E. Pingry, F. C. Proff, S. P. Quigley, C. W. Sanford, H. A. Schultz, J. H. Shores, R. H. Simpson, B. O. Smith, R. E. Stake, W. O. Stanley, Celia B. Stendler, L. M. Stolurow, J. R. Suchman, M. R. Sumption, M. Tatsuoka, L. R. Tucker.

Associate Professors: R. C. Anderson, M. D. Baughman, C. E. Bereiter, J. R. Burnett, J. A. Easley, Jr., D. C. Epperson, L. A. Fisher, J. G. Froehlich, O. E. Gould, P. E. Hemp, R. A. Henderson, Laura J. Jordan, Merle B. Karnes, F. H. Klassen, T. Manolakes, Mary Mather, C. J. McIntyre, F. McMurray, J. R. Palmer, V. E. Ricks, W. J. Schill, W. L. Shoemaker, Elizabeth Simpson, J. M. Slater, R. A. Tinkham.

Assistant Professors: T. H. Boardman, J. D. Boney, D. W. Brison, A. L. Brophy, G. A. Chambers, R. J. Colwell, C. B. Cox, W. H. Evans, Jo Ann Fley, G. R. Fuller, C. M. Gaverick, G. V. Glass, O. L. Hurley, H. Kackowski, H. A. Moses, Jean Phillips, W. R. Powell, W. M. Rogge, P. B. Shoresman, R. A. Smith, R. E. Spencer, Hazel Spitze, O. L. Springer, R. M. Tomlinson, C. J. Van Horn, J. L. Walker, J. R. Warmbrod.

Educational Administration and Supervision

COURSES FOR GRADUATES

430. **Elementary School Organization and Administration.** Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the elementary school. Examination is made of administrative roles in the design, implementation, and improvement of the total educational program. Intensive use is made of research skills and strategies in the investigation of problems of instruction. 1 unit. Prerequisite: Consent of instructor. Barnes, McGill, Springer.

438. **Instructional Supervision.** Methods, theories, and research applying to supervision at all levels of public education. Analyses are made concerning the work of curriculum directors, general supervisors, special supervisors, supervising principals, and department heads. Study of supervisory methods, current plans for staff utilization, use of instructional materials, evaluation of educational programs, and evaluation of the effects of supervision are stressed. 1 unit. Prerequisite: Elementary Education or Secondary and Continuing Education 439; Educational Administration and Supervision 460. Springer.

440. **Administration and Supervision of Junior and Senior High Schools.** Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the secondary schools. Problems are then projected through case studies and situational descriptions as a means of examining tasks and processes in such areas as curriculum and instruction, pupil and staff personnel, student activities, school organization and management, and school-community relationships. 1 unit. Prerequisite: Educational Administration and Supervision 460 or consent of instructor. Baughman, Hencley, McCleary.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

460. **Public Control and Administration of Education.** A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective administrative officers and supervisors. Not open to experienced administrators nor to students who have taken any of the following courses (or equivalents): Educational Administration and Supervision 430, 440, 461, 462, 464, 465, 466. 1 unit. CHAMBERS, HENCLEY, MILLER, SPRINGER.

461. **Administration of Educational Programs and Personnel.** Study of principles and criteria for analysis of programs at various levels of operation, such as instructional departments and pupil personnel service units, individual schools, local school systems, intermediate units, state education departments, and the federal government. Similar study is given to analysis of personnel requirements at various levels of operation. Educational Administration and Supervision 461, 462, and 463 constitute the required core program for all students specializing in educational administration who are candidates for a degree beyond the master's. 1 unit. Prerequisite: Educational Administration and Supervision 460 and 430 or 440. HENCLEY, MCCLEARY, MILLER, SPRINGER.

462. **Financial and Operating Structures of Public Education.** Study of relations of public education to the national economy; organization and operation of public school government; an analysis of theory and practice in school finance; processes of managing business affairs; role of law in school administration; and methods of survey, evaluation, and planning. 1 unit. Prerequisite: Educational Administration and Supervision 460; 430 or 440; 461. CHAMBERS, MCLURE.

463. **The Role of Administrative Leadership.** Study of principles underlying administrative leadership drawn from such disciplines as philosophy, psychology, sociology, and public administration. Application of these principles in the analysis and formulation of general procedures by which the process of administration may be carried on most effectively to develop and operate efficient educational programs. 1 unit. Prerequisite: Educational Administration and Supervision 460; 430 or 440; 462. HENCLEY, MCCLEARY, MILLER.

464. **Field Problems in Educational Administration.** Designed to give direct experience in the study of educational problems of concern to administrators. Each student selects and pursues one or more problems of study under the supervision of a professor. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

465. **Public School Finance and Business Administration.** The theory and practice of financing public education in the United States; development of guiding principles in educational finance, trends and needs in state and federal participation in school support, and local operational finance. Not open to students who have completed Educational Administration and Supervision 461 or 462. 1 unit. Prerequisite: Educational Administration and Supervision 460. MCLURE, MILLER.

466. **Public School Finance.** Advanced graduate study of the theory and technology of public school finance. Attention is centered on analysis of principles and theory underlying fiscal practice in various states; technical knowledge of designing controls, organization, and fiscal systems in harmony with expressed theory; and the application of research to the analysis of problems related to the improvement of financing public schools. 1 unit. Prerequisite: Educational Administration and Supervision 462 or consent of instructor. MCLURE.

468. **School-Community Relations.** Study of the relationship of the American school to the community. Analysis of the power structure, social agencies, school liaison groups, and economic character of the community as they affect and are affected by the school. Includes an evaluation of the various media of communication between the school and the larger community, and the development of criteria for an effective program of school-community relations. 1 unit. CHAMBERS, SPRINGER, SUMPTION.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupil, parents, teachers, administrators, and school board members in relation to the school. 1 unit. SUMPTION.

470. **Principles and Resources for School Plant Planning.** Study of principles for planning functional school buildings. Primary emphasis is placed on the planning process involved in meeting the building needs of the school district, including (1) analysis and projection of educational programs to be housed, (2) prediction of pupil enrollments, (3) site selection, (4) educational specifications of buildings, and (5) rehabilitation, remodeling, and modernization of existing buildings. 1 unit. Prerequisite: Educational Administration and Supervision 460 CHAMBERS.

490. **Seminar for Advanced Students of Education.** Seminar in educational administration and supervision open only to persons who have been admitted for doctoral study in educational administration and supervision. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

Educational Psychology

COURSES FOR GRADUATES

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundations, and its implications for education. 1 unit. Prerequisite: Educational Psychology 311 and 312. AUSUBEL, BLAIR, JONES.

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the preschool and elementary school years, with emphasis on development as a process of social learning; interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. 1 unit. Prerequisite: Educational Psychology 311 and 312. AUSUBEL, GARVERICK, JONES, STENDLER.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. 1 unit. Prerequisite: Educational Psychology 311, 312, and 390. R. H. SIMPSON.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. Psychoeducational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning,

the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis and use of test results and resource materials in this field. 1 unit. Prerequisite: A course in psychology; consent of instructor. GARVERICK, R. H. SIMPSON.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. 1 unit. Prerequisite: Educational Psychology 311 and 312; Educational Psychology 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR, JONES.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. 1 unit. Prerequisite: Educational Psychology 311 and 312. BONEY, BROPHY, KACZKOWSKI, OHLSEN, PROFF, SHOEMAKER, SLATER.

423. **The Use of Tests in Guidance.** Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. 1 unit. Prerequisite: Educational Psychology 392. BROPHY, HASTINGS, PATTERSON, PHILLIPS, PROFF.

424. **Supervised Practice in Counseling.** Study of the individual client through the use of the tools of the counselor. Each student is expected to develop professional skills by working with clients. 2 units. Prerequisite: Master's degree in guidance; consent of faculty committee. STAFF.

425. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Educational Psychology 325 are not given credit for Educational Psychology 425. 1 unit. STAFF.

426. **Diagnostic and Remedial Programs of the School.** A study of remedial programs in reading, spelling, English, arithmetic, handwriting, and content subjects. 1 unit. Prerequisite: A basic course in the teaching of reading; consent of instructor. POWELL.

427. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. 1 unit. Prerequisite: Educational Psychology 311, 312, 422, 423, and either 325 or 425; or consent of instructor. KACZKOWSKI, OHLSEN.

428. **The Analysis and Use of Occupational Information in Gudance Programs.** Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. 1 unit. Prerequisite: Educational Psychology 325 or 425, or consent of instructor. BROPHY, KACZKOWSKI, OHLSEN, SHOEMAKER.

429. **Field Instruction in Counseling.** Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. 1 or 2 units. Prerequisite: Educational Psychology 422 and 424 (with consent of instructor, registration in Educational Psychology 424 may be concurrent) . STAFF.

447. **Seminar in Rehabilitation Counseling.** Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publi-

cations. May be repeated for a maximum of one unit. ½ unit. Prerequisite: Educational Psychology 326 and 422. MOSES, PATTERSON.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in educational psychology open only to persons who have been admitted for doctoral study in educational psychology. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

492. **Psychology of Learning and Instruction.** Same as Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON, STOLUROW.

494. **Multivariate Analysis in Psychology and Education.** Same as Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis: profile similarity models; discriminatory analysis; multi-dimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. GLASS, TUCKER.

495. **Theory of Measurement.** Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307 or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. GLASS, STAKE, TUCKER.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. 1 unit. Prerequisite: Educational Psychology 390. GLASS, PINGRY, STAKE, TATSUOKA.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Analysis of variance and co-variance, experimental design, introduction to multivariate statistical techniques including discriminant analysis. 1 unit. Prerequisite: Educational Psychology 496. GLASS, TATSUOKA.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with empha-

sis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. 1 unit. Prerequisite: Educational Psychology 496. HASTINGS, STAKE.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understanding. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. ANDERSON, BLAIR, GARVERICK, JONES, R. H. SIMPSON.

312. **Mental Hygiene and the School.** An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

325. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in schools; what the teacher can do in guidance. Students may not register for credit in both Educational Psychology 325 and 425. ½ unit. Prerequisite: Eight semester hours in education and psychology. KACZKOWSKI, PROFF.

326. **Introduction to Vocational Rehabilitation Counseling.** A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and problems of vocational rehabilitation counseling. ½ unit. Prerequisite: Consent of instructor. MOSES, PATTERSON.

343. **Individual Intelligence Testing.** The fundamental concepts relevant to the general problem of the individual testing of learning aptitude. Acquisition of psychometric competence in the use of the 1960 Binet and the Wechsler tests. Acquaintance and limited practice in the administration, scoring, and interpretation of results obtained by means of performance scales and other devices appropriate for use with individuals having sensory, associative, and/or motor impairments. 1 unit. Prerequisite: Six hours of psychology and Special Education 324 or Educational Psychology 392 or Psychology 290, or equivalent. NEWLAND.

360. **Educational Uses of Television and Radio.** Same as Communications and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utlization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. The course includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. 1 unit. GLASS, HASTINGS, PINGRY, STAKE, TATSUOKA.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking proce-

dure. Designed primarily for classroom teachers. 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GRONLUND, HASTINGS, SPENCER.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GRONLUND, HASTINGS, SPENCER, STAKE.

Elementary Education

COURSES FOR GRADUATES

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. 1 unit. STAFF.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the following fields: (a) language arts, (b) social studies, (c) arithmetic, (d) science, (e) creative arts, (f) reading, (g) early childhood education. 1 unit. Prerequisite: For all sections, Elementary Education 431 or 434; for the section in language arts, Elementary Education 336 or a course in the teaching of reading or language arts, or consent of instructor; for the section in creative arts, Elementary Education 337 or consent of instructor; for the section in science, Elementary Education 335 or a methods course in teaching science in the elementary school and two years of college science, or consent of instructor; for the section in reading, Elementary Education 336 or a course in teaching of reading; for the section in early childhood education, Elementary Education 434. STAFF.

434. **Programs in Early Childhood Education.** An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. 1 unit. SPODEK, STENDLER.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. 1 unit. Prerequisite: Educational Psychology 312 or consent of instructor. R. A. SMITH, STENDLER, SUCHMAN.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. MCGILL, SHORES.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more

than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

455. **Theories of Art Education.** A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. 1 unit. Prerequisite: Elementary Education 337 or Secondary and Continuing Education 456, or consent of instructor. LANSING, R. A. SMITH.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of elementary education. 1 to 2 units. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in elementary education open only to persons who have been admitted for doctoral study in elementary education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the classroom teacher and the specialist. Opportunity for experience in field and laboratory work. ½ unit. Prerequisite: Elementary Education 233 and 237, or equivalent; two years of college science. ATKIN, R. W. BURNETT.

336. **Primary Reading.** Critical evaluation of current schools of thought with regard to the teaching of reading and an analysis of the concept of learning as well as the meaning of reading upon which each school is based. Attention is given to reading as a part of the total growth process of the child and to knowledge of methods and materials used in teaching beginning reading. ½ unit. Prerequisite: Junior standing. DURKIN, MOORE, POWELL, SHORES.

337. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. ½ unit. Prerequisite: Junior standing. BREEN, LANSING, SCHULTZ, R. A. SMITH.

History and Philosophy of Education

COURSES FOR GRADUATES

400. **Problems of Educational Theory.** Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305. MCMURRAY.

401. **Modern Theories of Education.** A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. 1 unit. STANLEY.

402. **Educational Movements in the Twentieth Century.** A historical study of significant educational trends during the past sixty years, with special reference to

their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. 1 unit. Prerequisite: History and Philosophy of Education 300, or 302, or 403, or consent of instructor.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. 1 unit. Prerequisite: History and Philosophy of Education 300 or 302, or consent of instructor.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. BROUDY.

405. **Foundations of Aesthetic Education.** A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas investigated. 1 unit. Prerequisite: Consent of instructor. BROUDY.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop an understanding of, and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment and knowing, examined from the standpoint of recent developments in pragmatism. 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. **Advanced Philosophy of Education.** A systematic exploration of knowledge and inquiry as they relate to problems of formulating educational policy, curriculum design, organization of the school system, and teaching-learning. Selected materials in the history of epistemology are examined and emphasis is placed on a critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

409. **Advanced Philosophy of Education.** A study of the nature of value as it relates to problems of formulating and justifying educational aims and policies, curriculum design, organization of the school system, and teaching-learning. Selected materials in ethics, value theory, and aesthetics are used in the critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. De-

signed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in education. BROUDY, B. O. SMITH, STANLEY.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in history and philosophy of education open only to persons who have been admitted for doctoral study in history and philosophy of education. Sections are usually offered in the following fields: (a) history of education, (b) philosophy of education, (c) comparative education, (d) social foundations of education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **The History of Education.** Brief introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. ½ unit. Prerequisite: Junior standing.

301. **Philosophy of Education.** Based on Dewey's *Democracy and Education,* this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. ½ unit. J. R. BURNETT, MCMURRAY, STANLEY.

302. **History of American Education.** The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. ½ unit.

303. **Comparative Education.** A study of selected national systems of education in their differing cultural settings. ½ unit. KAULFERS.

304. **Social Foundations of Education.** An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. ½ unit. J. R. BURNETT, PALMER, B. O. SMITH, STANLEY.

305. **History of Educational Ideas.** Through a study of selected educational theorists and intellectual movements, this course provides familiarity with the major educational ideas of the past, as well as historical perspectives on current issues and problems in education. Readings in Plato, Quintilian, St. Augustine, Loyola, Comenius, Rousseau, Pestalozzi, Froebel, Herbart, Dewey, and others. ½ unit.

315. **Sociology of Education.** Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

Secondary and Continuing Education

COURSES FOR GRADUATES

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. STAFF.

441. **Linguistic and Logical Analysis of Teaching.** An analysis of teaching from the standpoint of semantic and logical factors. Topics such as theories of meaning, definition, explanation, and justification as employed by a teacher are discussed. 1 unit. K. B. HENDERSON, B. O. SMITH.

448. **Continuing Education.** Development, status, and prospects of continuing education for adults. Institutions, agencies, and programs; public policy and policy-making for continuing education; organization, administration, finance, and promotion; recruiting, training, and supervising staff; planning programs and courses; the literature of continuing education. Systematic study of individual problems supplements class work. ½ or 1 unit. PHIPPS.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

456. **Problems and Trends in Specialized Fields of Secondary Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. 1 unit. Sections are usually offered in the following fields:

(a) **English.** DEBOER, EVANS.
(b) **Foreign Languages.** CANNADAY, KAULFERS, KETTLEKAMP.
(c) **Mathematics.** K. B. HENDERSON, PINGRY.
(d) **Science.** R. W. BURNETT, GOULD, SHORESMAN.
(e) **Social Science.** COX, METCALF.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of secondary and continuing education. 1 to 2 units. STAFF.

467. **The American College.** Development of the American college and university; higher education processes, organization, and administration; the variety of problems and conflicting theories; policies, practices, and present trends. 1 unit. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in secondary and continuing education open only to persons who have been admitted for doctoral study in secondary and continuing education. 1 to 2 units. METCALF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

Special Education

COURSES FOR GRADUATES

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis, and social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, and anthropology, and psychology to educational theory and practice with reference to the mentally deficient. 1 unit. Prerequisite: Special Education 322 or consent of instructor. R. A. Henderson, S. A. Kirk.

417. **Psycho-Educational Problems of Exceptional Children.** A course for educators, students in the behavioral sciences, and students beginning graduate study in special education. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children and consideration of major current problems in the development of educational programs. 1 unit. Prerequisite: Sixteen hours of psychology and/or education or consent of instructor. Bereiter, R. A. Henderson.

418. **Communicative Problems of the Deaf.** An advanced course in the problems of the deaf in communication, including the learning of language, reading, speech, speech reading, and research in these areas. Consideration is given to the various methods that are used in the teaching of these basic skills to deaf children and to the social and psychological principles underlying the methods. 1 unit. Prerequisite: Consent of instructor. Quigley.

419. **Diagnosis of Learning Disabilities.** A clinical course in the diagnosis of learning disorders in children with particular emphasis on psycholinguistic and reading disabilities. The course includes study of the genetic, neurophysiological and psychological theories and constructs relating to learning disorders, and provides laboratory practice in the diagnosis of children with learning disorders. 1 unit. Prerequisite: Psychology 433 or Educational Psychology 343. S. A. Kirk.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, and of the somato-psychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. Implications for current educational programs for the handicapped are analyzed. 1 unit. Prerequisite: Special Education 117 or 417 and Educational Psychology 312, or consent of instructor. Farber, Gallagher, Newland.

421. **Administration and Supervision of Special Education.** Designed for advanced graduate students preparing for administrative or supervisory positions in special education programs. Administrative and supervisory practices in educating exceptional children are examined with emphasis on special education programs in the public schools; application of administrative theory to special education programs. Field trips to observe and evaluate programs are required. 1 unit. Prerequisite: Special Education 417; Educational Administration and Supervision 460; consent of instructor. R. A. Henderson, M. B. Karnes.

444. **Practicum in Remediation of Learning Disabilities.** A clinical course in the remediation of learning disabilities in children. The course includes a study of remedial philosophies, the relationships between diagnosis and remediation, specific remedial techniques, and their applicability to certain learning disorders, and provides supervised clinical practice in planning, executing, and reporting remedial programs. 1 unit. Prerequisite: Special Education 419. Kirk.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropri-

ate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

456. **Problems and Trends in Special Education.** Introduces the student to significant problems, points of view, and trends in the field concerned. Significant research related to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, and (g) culturally disadvantaged children. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of special education. 1 to 2 units. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in the education of exceptional children open only to persons who have been admitted for doctoral study in special education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. **The Gifted Child in School and Society.** A consideration of the gifted in society; who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. ½ to 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GALLAGHER, ROGGE.

317. **Psycho-Social Educational Aspects of Deafness.** Historical and current societal perceptions of the deaf; analysis of the various effects and patterns of auditory impairment on children and adults; intelligence, personal and social adjustment, the psychological processes, and how they affect the acquisition of language, speech, speech reading, reading, and writing, ½ to 1 unit. Prerequisite: Special Education 117 and Psychology 100 or Educational Psychology 211. QUIGLEY.

318. **Workshop and Laboratory in Education of Exceptional Children.** For those specializing in exceptional children. The following sections may be offered: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

319. **Special Education of the Deaf, I.** Survey of the curriculum and techniques in preschools, kindergarten, primary, and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child; study of sense training, lip reading, vocabulary development, reading techniques, elementary school subjects, language and speech development, auditory training, and curriculum construction. 1 to 1½ units. Prerequisite: Consent of instructor. SCHMITT.

320. **Special Education of the Deaf, II.** Continuation of Special Education 319. 1 to 2 units. Prerequisite: Special Education 319. SCHMITT.

321. **Education of Disturbed and Conduct-Problem Children.** A study of the social, emotional, and learning characteristics of children who are disturbed or who exhibit problems of conduct; methods of diagnosis and differentiation; educational environments and teaching methods used for their remediation. ½ to 1 unit. Prerequisite: Special Education 117 or equivalent; Elementary Education 236 or equivalent. BRENTRO.

322. **Psychology and Education of the Mentally Handicapped.** A study of the social, emotional, physical, and learning characteristics of mentally handicapped children; methods of diagnosis and differentiation; curriculum and teaching techniques employed for their education. ½ unit. Prerequisite: Elementary Education 231. JORDAN.

323. **Psychology and Education of the Mentally Handicapped** Continuation of Special Education 322, with emphasis on curriculum. ½ unit. Prerequisite: Special Education 322. JORDAN.

324. **Mental and Educational Measurement of Exceptional Children.** Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech defective. ½ or 1 unit. Prerequisite: Special Education 117 or consent of instructor. HURLEY.

Vocational and Technical Education

COURSES FOR GRADUATES

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. 1 unit.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. 1 unit. MATHER, E. SIMPSON, SPITZE.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. 1 unit. MATHER.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. 1 unit. E. SIMPSON.

456. **Problems and Trends in Specialized Fields of Vocational and Technical Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections are usually offered

in the following fields: (a) agricultural education, (b) business education, (c) home economics education, (d) industrial education. 1 unit. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of agriculture, business, home economics, and industry. ½ or 1 to 2 units. STAFF.

471. **Policy and Program Development for Education in Agriculture.** Local, state, and national policies for agricultural education; organizing for policy-making; developing desirable policies and programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. Open to school administrators and extension educators without prerequisite. PHIPPS.

472. **Course Planning and Teaching Procedures in Vocational Agriculture.** Gathering data essential in course planning, constructing course plans, developing resource units, teaching procedures, and instructional aids. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. FULLER, HEMP.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. HEMP, KREBS.

474. **Supervised Agriculture Experience in Vocational Agriculture.** Supervised agricultural experience programs as an educational strategy; importance and meaning of supervised agriculture experiences; planning, conducting, supervising, and evaluating agriculture experience programs; relation of supervised agriculture experience programs to establishment and advancement in an occupation; keeping and using records; relating class instruction to supervised agriculture experience programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. PHIPPS, WARMBROD.

475. **Organizing and Teaching Agriculture Mechanics.** Agriculture mechanics as a phase of vocational education in agriculture; purposes, course planning for high school students, young farmers, and adults; methods of teaching and evaluating on-farm or on-job instruction; planning agriculture-mechanics shops and facilities; providing and teaching safety in agriculture mechanics. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. PHIPPS.

476. **Guidance in Agricultural Education.** The guidance function in young farmers' and adult farmers' classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment, placement, follow-up. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. KREBS.

481. **History and Basic Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. 1 unit. CAMPBELL.

482. **Research Studies in Vocational and Technical Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research project, or plans in detail a major research project to be completed later. 1 unit. R. EVANS, PHIPPS, SCHILL, E. SIMPSON.

487. **Seminar in Vocational, Technical, and Practical Arts Education.** Overview and interpretation of social, economic, and technological trends which have rele-

vance to the problem of developing new programs in the vocational, technical, and practical arts areas; analysis and evaluation of innovations in the field; current issues and problems. 1 unit. Prerequisite: Graduate standing in vocational and technical education. M. R. KARNES, PHIPPS, SCHILL, E. SIMPSON.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses; study of basic concepts underlying course construction in industrial education. 1 unit. Prerequisite: Undergraduate work in appropriate vocational and technical education courses. CAMPBELL, STERN.

489. **Administration and Supervision of Vocational and Technical Education.** Problems and approved practices in the administration and supervision of programs of vocational, technical, and practical arts education in secondary schools, junior colleges, and technical institutes. 1 unit. Prerequisite: Consent of instructor. M. R. KARNES, TOMLINSON.

490. **Seminar for Advanced Students of Education.** Seminar in vocational and technical education open only to persons who have been admitted for doctoral study in vocational and technical education. Sections of this seminar are usually offered in the following areas: (a) industrial education; (b) agricultural education; and (c) home economics education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructors to schools in which first-year teachers are employed. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. FULLER, WARMBROD.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. ½ or 1 unit. TOMLINSON.

382. **Cooperative Vocational and Technical Education Programs.** This course is designed to provide the specific professional background required of teachers, coordinators, and administrators who organize and conduct public school programs utilizing community resources and experiences. The course includes the background, philosophy, organization, and administration of cooperative education. ½ or 1 unit.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. ½ or 1 unit. STERN.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. 1 unit. Prerequisite: Sixteen hours in appropriate vocational and technical education courses. STERN, TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, and their relationships to other educational agencies. 1 unit. SCHILL.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Ten hours of undergraduate credit in appropriate vocational and technical education courses. CAMPBELL, TOMLINSON.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the Master of Science and Doctor of Philosophy is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. To be admitted, an applicant must have the equivalent of a grade-point average of 4.0 or B for the last sixty semester hours of undergraduate study. Courses for advanced undergraduates and graduates are also open for credit to qualified students majoring in other fields.

A minimum of eight units must be completed for the master's degree, including a thesis. At least four units must be at the 400 level, including a course in circuit theory and one in field theory. In addition, graduate or undergraduate credit in a modern physics course is required.

All students desiring to enter the doctoral program must take the electrical engineering qualifying examination. Students who earn the master's degree at the University of Illinois take the examination during the term they earn their eighth unit of graduate credit. Students who enter with the master's degree must take the examination during their first term here.

Eight units of course credit beyond the master's degree, or the equivalent, plus eight units of thesis research and a satisfactory thesis, are minimum requirements for the Doctor of Philosophy. In addition, the candidate must demonstrate reading proficiency in two of the following languages: French, German, Russian. He also must have completed two courses in modern physics. In his course program he must offer a major and either one or two minors. A single minor requires four units in one field outside the major field, at least one of which must be at the 400 level. If two minors are chosen, each must consist of at least two units. Advanced courses in mathematics, physics, physiology, chemistry, nuclear engineering, and other branches of engineering are recommended minors.

Further details may be found in the *Electrical Engineering Graduate Study Manual,* available from the department.

GRADUATE FACULTY

Professors: E. C. JORDAN (Head of Department), W. E. MILLER (Associate Head of Department), H. W. ADES, F. ADLER, G. E. ANNER, W. R. ASHBY, D. S. BABB, A. D. BAILEY, J. BARDEEN, S. A. BOWHILL, R. M. BROWN, P. D. COLEMAN, J. B. CRUZ, G. A. DESCHAMPS, F. DUNN, W. L. EMERY, W. L. EVERITT, G. H. FETT, W. J. FRY, L. GOLDSTEIN, P. HANDLER, H. N. HAYWARD, M. S. HELM, C. D. HENDRICKS, F. E. HOHN, N. HOLONYAK, D. F. HOLSHOUSER, W. MAYEDA, P. E. MAYES, M. S. MCVAY, D. E. MULLER, S. MUROGA, G. R. PEIRCE, D. PINES, W. J. POPPELBAUM, J. E. ROBERTSON, C. T. SAH, P. F. SCHWARZLOSE, M. D. SIRKIS, G. W. SWENSON, G. J. THOMAS, H. M. VON FOERSTER, N. WAX, H. D. WEBB.

Associate Professors: W. G. ALBRIGHT, R. B. ASH, D. L. BITZER, R. W. BURTNESS, J. H. CAHN, R. T. CHIEN, D. H. COOPER, M. H. CROTHERS, J. D. DYSON, P. R. EGBERT, E. W. ERNST, F. J. FRY, O. L. GADDY, D. F. HANG, E. C. HAYDEN, J. O. KOPPLIN, B. C. KUO, G. H. LEICHNER, Y. T. LO, P. E.

MAST, R. MITTRA, T. A. MURRELL, J. P. NEAL, W. R. PERKINS, J. T. VERDEYEN, K. C. YEH.

Assistant Professors: J. R. BAIRD, M. L. BABCOCK, K. G. BALMAIN, J. W. BEAUCHAMP, E. C. JONES, P. W. KLOCK, G. A. METZE, N. NARAYANA RAO, S. R. RAY, J. A. RESH, J. M. SCHNEIDER, C. F. SECHRIST, M. SOBRAL, T. N. TRICK.

COURSES FOR GRADUATES

400. Seminar. Required of all graduate students. No credit.

412. Advanced Engineering Measurements. Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. 1 unit.

414. Engineering Applications of Linear Graphs. Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416, Mathematics 315 or 318.

415. Control System Theory and Design. Synthesis of feedback control systems to meet design specifications, including sensitivity; multivariable systems; introduction to systems with random inputs; state variable techniques; nonlinear systems. 1 unit. Prerequisite: Electrical Engineering 386 or equivalent, or consent of instructor.

416. Analysis of Linear Networks and Systems. Basic course in networks; frequency and time-domain analysis; foundations of loop and node equations; signal flow graph formulations: Fourier and Laplace transforms; two-port parameters; introduction to network function theory. 1 unit. Prerequisite: Credit or registration in Mathematics 346 or 348; Electrical Engineering 322 or equivalent.

418. Electric and Magnetic Fields. Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. 1 unit.

420. Electromagnetic Waves and Radiating Systems. Fundamental electromagnetic theory with applications to transmission lines, waveguides, and antennas; introduction to the solution of advanced problems in static electric and magnetic fields. 1 unit. Prerequisite: Electrical Engineering 352.

421. Advanced Electromagnetic Engineering. Reciprocity and equivalence principles; formulation of scattering and diffraction problems; approximations for large and for short wavelengths; plane, cylindrical, and spherical wave problems; variational methods; Wiener-Hopf techniques; applications to antennas and waveguide problems. 1 unit. Prerequisite: Electrical Engineering 420.

422. Advanced Communication Networks. Fourier integral and matrix algebra, analysis of networks, and network synthesis for wide band operation. 1 unit.

423. Gaseous Electronics and Plasmas. Irreversible thermodynamics; transport theory; magnetohydrodynamics; collective behavior. 1 unit. Prerequisite: Physics 362 and Electrical Engineering 420, or equivalent.

425. Quantitative Neuroanatomy Lecture. Same as Physiology 425. A detailed consideration of (1) quantitative methods of studying structure in the central nervous system, (2) analysis of quantitative data concerning cell and fiber populations and related characteristics in both normal and modified brains, and (3) derivation of neuronal circuitry. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor.

426. **Quantitative Neuronanatomy Laboratory.** Same as Physiology 426. Practice in the use of quantitative methods for precisely determining nerve cell populations and other components of the central nervous system and in measuring properties of subcellular components of anatomic significance. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor.

427. **Boundary Value Problems.** Derivation and solution of partial differential equations and integral equations of mechanics and electricity and magnetism; study of the analysis of wave motions. 1 unit.

428. **Analysis of Nonlinear Systems.** Same as Theoretical and Applied Mechanics 428. Singular points and stability considerations are treated. Graphical and analytical methods, including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations, are considered. 1 unit. Prerequsite: Mathematics 341; consent of instructor.

429. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedback circuits and amplifiers, stability, equalizers, and relations between components of network functions. 1 unit.

431. **Theory of Guided Waves.** Propagation in general cylindrical waveguides; Eigenvalue problems; stationary principles; microwave circuit theorems, boundary value problems, and the determination of circuit parameters; periodically loaded waveguides with anisotropic media. 1 unit. Prerequisite: Electrical Engineering 420.

434. **Random Processes in Electrical Engineering.** Survey of measure theoretic probability theory; analysis of second order random processes, including the spectral theory and harmonic analysis; transmission of noise through linear and nonlinear systems; the signal detection problem. 1 unit. Prerequisite: Mathematics 361.

435. **Theory of Semiconductors and Semiconductor Devices.** Same as Physics 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

437. **Principles of Microwave Measurements.** Generation and detection of the laboratory signal; the generalized impedance concept; matrix representation of waveguide discontinuities; determination of equivalent network parameters; analysis of measurement techniques by signal flow graphs; accuracy criteria. 1 unit. Prerequisites: Electrical Engineering 355 and 356.

440. **Advanced Power Circuit Analysis, I.** Analysis of power systems by symmetrical and related components; equivalent circuits of lines, transformers, and machines; fault calculations on symmetrical and unsymmetrical power systems; the network analyzer in fault studies. 1 unit.

442. **Advanced Analysis of Alternating Current Machinery.** Steady-state analysis of synchronous machines, round rotor and salient poles, magneto-motive forces with symmetrical and unsymmetrical windings, torque angle characteristics, vibration, and noise. 1 unit.

443. **Analysis of Dynamo Machines Under Transient Conditions.** Analysis of the operation of alternating and direct current machines under transient conditions, armature and field phenomena and mutual reactions of dynamo machines with system transients. 1 unit. Prerequisite: Electrical Engineering 442.

445. **Power System Stability.** Transient and steady-state stability in power systems; power flow equations; transient stability swing curves; critical clearing time; the network analyzer in stability studies; the analog computer in transient stability studies. 1 unit. Prerequisite: Electrical Engineering 440.

451. **Network Synthesis.** A study of methods for the synthesis of networks for prescribed driving-point and transfer characteristics. 1 unit. Prerequisite: Mathematics 345.

452. **Network Synthesis.** A continuation of Electrical Engineering 451. 1 unit. Prerequisite: Electrical Engineering 451.

453. **Optimum Control Systems.** Formulation of the optimization problem; controllability; observability; stability; Lyapunov's second method; application of variational calculus, maximum principle and principle of optimality to control problems; stochastic control; adaptive control. 1 unit. Prerequisite: Electrical Engineering 415.

454. **Sampled-Data Control Systems.** Analysis and design of feedback control systems with digital and sampled data. 1 unit. Prerequisite: Electrical Engineering 386 or 415, or equivalent.

456. **Coding Theory.** General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data-transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

463. **Information Theory.** Same as Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or Electrical Engineering 433.

467. **Atomic Collision Processes.** Same as Physics 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photoprocesses and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

472. **Quantum Electronics.** A brief theoretical introduction to quantum mechanics and atomic physics, with many applications in spin resonance and modern maser theory. 1 unit. Prerequisite: Physics 381. It is recommended that Physics 362 and 385 be taken before registering in this course.

473. **Fundamentals of Cybernetics.** Same as Biophysics and Communications 435. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 394 or Mathematics 361, or consent of instructor.

474. **Problems of Cybernetics.** Same as Biophysics and Communications 436. A continuation of Electrical Engineering 473. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Electrical Engineering 473.

475. **Ionospheric Radio Propagation.** Propagation in a stratified medium; WKB solution; ray theory; ionospheric sounding; ionospheric transmission problems; scattering by irregularities; propagation in a random medium; cross-modulation and nonlinear effects; magneto-ionic theory; Faraday effect; whistler propagation; coupling of characteristic waves; magneto-hydrodynamic waves; formation of ionospheric E-region; formation of F-region. 1 unit. Prerequisite: Electrical Engineering 420 or equivalent.

481. **Threshold Logic.** Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. **Theory of Digital Computer Arithmetic.** This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Mathematics or Electrical Engineering 394.

485. **Advanced Theory of Magnetic and Optic Computer Memory Devices.** Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media: modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Electrical Engineering 385.

486. **Constitution of the Ionosphere: An Introduction to Aeronomy.** Same as Astronomy 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ions of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent.

490. **Seminar in Special Topics.** Lectures and discussions on current research and literature on advanced topics in electrical engineering. Course may be repeated. 0 to ½ unit. Prerequisite: Advanced standing; consent of instructor.

497. **Electrical Engineering Problems.** Lectures and discussions relating to new areas of interest. 0 to 1 unit. May be repeated. Prerequisite: Consent of instructor.

498. **Individual Study.** Individual projects. ½ to 2 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

322. **Linear Network Theory, II.** Signal representation in terms of Fourier series, Fourier transforms, and Laplace transforms; role of exponential and sinusoidal signals in system analysis for arbitrary waveforms; two-ports and filters as signal processors. 0 to 1 unit. Prerequisite: Electrical Engineering 250 and 251; Mathematics 195 and 345.

323. **Circuit Laboratory.** To accompany Electrical Engineering 322 and 350. 0 or ¼ unit. Prerequisite: Electrical Engineering 251 and 322; credit or registration in Electrical Engineering 350.

324. **Introduction to Network Synthesis.** An introduction to modern methods of network synthesis; properties of driving-point and transfer functions; approximation and scaling; LC, RC, and RLC synthesis methods; ladder network development; and resistively terminated coupling networks. 0 to 1 unit. Prerequisite: Electrical Engineering 322.

330. **Magnetic Circuits and Transformers.** Magnetic circuit analysis; transformer theory; special magnetic circuit applications. 0 to ¾ unit. Prerequisite: Electrical Engineering 229, 250, and 251; credit or registration in Electrical Engineering 331.

331. **Magnetic Circuits and Transformers Laboratory.** To accompany Electrical Engineering 330. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330.

332. **Electrical Machinery.** Induction machines; single-phase motors; direct-current machines; application. 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 332. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

336. **Advanced Analysis of Electric Power Equipment.** Transformers, synchronous and induction machines; power machines in systems; single phase motors; extension of the two-reaction analysis to the general machine. 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331.

340. **Electronics.** Emission, electron ballistics, high vacuum electron tubes, semiconductors and transistors, tube and transistor characteristics and equivalent circuits, gaseous conduction and gas tubes, introduction to methods of analysis. 0 to ¾ unit. Prerequisite: Electrical Engineering 250 and 251.

341. **Electronics Experimentation.** Problems of experimentation and measurement with electronic circuits and devices. Lecture and laboratory. 0 or ¼ unit. Prerequisite: Electrical Engineering 251; credit or registration in Electrical Engineering 340.

342. **Advanced Electronics.** Linear and nonlinear amplification; modulation and demodulation concepts; introduction to feedback amplifiers and oscillators. 0 to ¾ unit. Prerequisite: Electrical Engineering 322, 340, and 341.

343. **Electronics Laboratory.** 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 342.

347. **Industrial Electronics.** Electronic circuits for automatic control and measurement systems with applications. 0 to 1 unit. Prerequisite: Electrical Engineering 322, 330, and 342. Credit toward graduation is not given for both Electrical Engineering 347 and 381.

349. **Electron Tube Circuits.** Linear and nonlinear amplifiers, fundamentals of modulation and detection, oscillators, rectifiers. 0 to 1 unit. Prerequisite: Electrical Engineering 342.

350. **Lines, Fields, and Waves.** Transmission lines, field calculations, and wave propagation. ¾ unit. Prerequisite: Electrical Engineering 229; Mathematics 195; credit or registration in Electrical Engineering 323.

352. **Electromagnetic Fields.** Uniform plane waves, wave guides, radiation and propagation of electromagnetic energy, radiating systems, and electrodynamics. ¾ unit. Prerequisite: Electrical Engineering 350 and 323; concurrent registration in Electrical Engineering 356 is recommended.

353. **Radio Circuits.** Component behavior at communication frequencies, impedance transforming networks for single and multiple frequencies; low-level tuned and compensated amplifiers, broad band impedance matching; equalizers. 0 to 1 unit. Prerequisite: Electrical Engineering 322 and 340.

355. **Fields and Waves.** Electromagnetic fields; wave guides; radiation and propagation of electromagnetic energy; radiating systems. 0 to ¾ unit. Prerequisite: Electrical Engineering 229 and 350, or consent of instructor.

356. **Microwave Techniques.** UHF and microwave sources and detectors; laboratory techniques for UHF and microwave frequencies. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 352 or 355.

357. **Radio Astronomy.** Same as Astronomy 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108.

359. **Introduction to Noise and Information Transmission.** Signals and their spectra; methods of communication systems analysis; modulation by AM, FM, PAM, PPM; origin of noise, properties of noise, introduction to probability theory, system comparison using statistical approach. ¾ or 1 unit. Prerequisite: Electrical Engineering 322; credit or registration in Electrical Engineering 342.

366. **Aeronomy: Physics of Upper Atmosphere and Space.** Same as Astronomy and Physics 366. Structure and composition of the earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

376. **Symmetrical Component Analysis of Power Systems.** Representation of power systems; symmetrical components, positive, negative and zero sequence impedances of network components, sequence networks; unsymmetrical faults, unsymmetrical power systems, matrix algebra in symmetrical component analysis. 0 to 1 unit. Prerequisite: Electrical Engineering 350.

378. **Electric Power Networks.** Steady-state power network analysis; inductive coordination; transmission line capacitance and resistance; networks synthesis; applica-

tion of computers to power network problems. 0 to 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

381. **Pulse Techniques.** An introduction to the response of electrical networks to nonsinusoidal inputs, the analysis of active circuits with large signals, and the circuits and techniques used in pulse and digital equipment. 0 to 1 unit. Prerequisite: Electrical Engineering 322, 340 and 341, or consent of instructor.

382. **Transistor Circuits.** This course is the same as Electrical Engineering 383 but has one three-hour laboratory added each week. 1 unit. Prerequisite: Electrical Engineering 342, credit or registration in Metallurgical Engineering 384, or consent of instructor.

383. **Transistor Circuits.** Junction transistors, diodes, and related semiconductor devices. Emphasis equally divided between device properties as related to semiconductor physics and circuit properties. Small signal theory of amplifiers and oscillators, large signal theory of power stages and switching circuits, negative resistance effects, high frequency limitations. ¾ unit. Prerequisite: Electrical Engineering 342, credit or registration in Metallurgical Engineering 384, or consent of instructor.

385. **Theory of Semiconductor Computer Devices.** Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization, and noise theory; integrated circuits technology: masking, oxidizing, and etching; emphasis on device-theoretical background for computer logic design. ¾ or 1 unit. Prerequisite: Mathematics or Electrical Engineering 294, or consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. 0 to 1 unit. Prerequisite: Consent of instructor.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. 0 to 1 unit. Prerequisite: Electrical Engineering 340, 341, and Mathematics 345, or consent of instructor.

389. **Communication Design.** Over-all communication design problems; kinds of propagation; noise and interference; antenna temperature; transmitter power requirements; frequency selection; design of a portion of a receiver, transmitter, or antenna. 0 to ¾ unit. Prerequisite: Electrical Engineering 342 and 350.

391. **Boolean Algebra and Switching Theory.** Same as Mathematics 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. 1 unit. Prerequisite: Consent of instructor.

392. **Introduction to Automata Theory.** Same as Mathematics 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Electrical Engineering or Mathematics 391, or consent of instructor.

393. **Digital Computer Circuit Design.** Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Mathematics or Electrical Engineering 294 or 391; credit or registration in Electrical Engineering 382 or 383, or consent of instructor.

394. **Logical Design of Automatic Digital Computer Circuits.** Same as Mathematics 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Electrical Engineering 294 or consent of instructor.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric and Composition)

Students who wish to be considered for admission to graduate work in English must have attained a grade-point average of at least 4.0. However, students whose averages are between 3.75 and 4.0 are considered on an individual basis. All students must present the equivalent of at least twenty hours of undergraduate work in English or American literature, although students with at least fourteen hours may be considered on an individual basis and granted probational entrance. This does not include required college work in rhetoric.

Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates must take English 446 and are required to choose at least three of their courses from those at the 300 level and three from those at the 400 level. Candidates must complete two courses in each of three areas of study as recognized by the department and must demonstrate proficiency in one language chosen from French, German, or Russian.

Candidates must also pass a final examination. A master's thesis is not required, but each candidate must deposit one term paper with the department.

Master of Arts in the Teaching of English. Candidates must earn at least four units in English, at least two of them in courses at the 400 level, and they must take the final examination for master's candidates in English. They must also deposit one term paper with the department. Candidates must also have had the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, Russian, or Spanish.

Specific requirements are divided into two programs, the first for those who have the Bachelor of Arts in English and the teacher's certificate, and the second for those who have the Bachelor of Arts in English but not the teacher's certicate.

For those with the certificate, the requirements are English, four units, including English 446 and at least one course above the 450 level; education, two units as follows: one unit in Educational Psychology 311 and 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high school teachers of English, as follows: one unit of either Secondary and Continuing Education 456 or English 447; one-half to three-quarters unit of either English 387 or Rhetoric 480; electives as needed to total at least eight units.

For those without the certificate, the requirements are English, four units, including English 446 and at least one course above the 450 level; education, two units as follows: one-half unit in Educational Psychology 311, one-half unit in Educational Psychology 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high school teachers of English, one-half to three-quarters unit in either English 387 or Rhetoric 480; electives, one-half to one unit as needed to total eight units. In addition to these courses, the candidates must take, without graduate credit, Secondary and Continuing Education 241 and 242. This program is designed to permit candidates to complete their work and qualify for a certificate and master's degree in two semesters and a summer. Those who lack certain prerequisites, such as general psychology, may need a little more time.

Electives may be in English, in education, or in exceptional cases, in other subjects.

Doctor of Philosophy in English. In addition to satisfying the general requirements of the Graduate College, candidates must take at least two units of work in problems courses—those courses numbered 450 and higher. The department recommends that all work be taken at the 400 level.

English 445 and 446. All entering graduate students are required to take English 445 and 446, Introduction to Advanced Graduate Study, during their first two semesters in residence, summer session not included.

Proficiency Examination. Graduate students entering the doctoral program after taking degrees at other institutions are required to take a proficiency examination early in their first semester—or summer session—of residence.

Foreign Languages. Each student must demonstrate proficiency in two languages chosen from French, German, or Russian; but, with the approval of the adviser and the head of the department, he may petition the Dean of the Graduate College to be allowed to substitute Latin or Greek for one of these languages.

Minor Subjects. Students may offer a double minor, which includes English philology and one other subject, or a sole minor in English philology.

Preliminary Examination. This examination is given in October and February of each year. It consists of two parts, a written examination and an oral examination.

Thesis. The student must submit a statement of his thesis plan, outlining its main topics, to the adviser within a reasonable period—usually six months—after he passes his preliminary examination.

More detailed information may be obtained by requesting a mimeographed statement, "Graduate Studies in English," from the Director of Graduate Students, Department of English, 100 English Building.

GRADUATE FACULTY

Professors: L. F. Dean (Head of Department), A. L. Altenbernd, A. E. Barker, J. J. Campbell, E. H. Davidson, G. B. Evans, J. T. Flanagan, R. A. Gettmann, R. L. Haig, B. Harkness, A. G Holaday, J. N. Hook, W. H. McBurney, B. A. Milligan, S. Paul, R. W. Rogers, C. H. Shattuck, D. A. Smalley, J. Stillinger, H. W. Wilson.

Associate Professors: Katharine Aston, L. E. Berry, G. P. Haskell, J. F. Lynen, S. Millet, F. B. Moake, R. L. Schneider, A. L. Scott, G. Scouffas, G. B. Stillwell, Priscilla Tyler, B. F. Wilkie.

Assistant Professors: E. J. Brandabur, H. C. Cole, Sanford Golding, F. E. Hodgins, U. M. Kaufmann, J. B. Trahern, R. H. Wasson, G. G. Wright.

English Literature and American Literature

COURSES FOR GRADUATES

401. **Old English: Anglo-Saxon.** An introduction to the language before 1000 A.D. 1 unit.

402. **Old English: Beowulf.** 1 unit. Prerequisite: English 401.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. 1 unit.

404. **Old English Literature and Its Cultural Background.** An intensive, critical examination of Old English prose and poetry exclusive of Beowulf. The texts studied vary from year to year, but particular attention is given to such important bodies of writing as the Elegies, the *Anglo-Saxon Chronicle,* and the works of Cynewulf, Aelfric, Alfred, and Wulfstan. 1 unit. Prerequisite: English 401 and 402.

405. **Middle English.** Introduction to Middle English dialects, with special emphasis on the East Midland. 1 unit. Offered in 1966-1967 and in alternate years.

406. **Middle English Literature and Its Cultural Background.** English literature from 1100 to 1500 (excluding Chaucer), with emphasis on chronicle, romance, debate, lyric, and such major poems as *Pearl, Sir Gawain and the Green Knight,* and *Piers Plowman;* historical, social, and religious backgrounds. 1 unit.

407. **Studies in Chaucer and His Times, I.** A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. 1 unit.

408. **Studies in Chaucer and His Times, II.** Continuation of English 407. 1 unit.

411. **Studies in Sixteenth-Century Literature, I.** 1 unit. MILLIGAN.

412. **Studies in Sixteenth-Century Literature, II.** Continuation of English 411. 1 unit. MILLIGAN.

413. **Studies in Shakespeare.** 1 unit. EVANS.

414. **Studies in Elizabethan Drama.** 1 unit.

416. **Studies in Late Renaissance Thought and Literary Theory.** The development of cultural ideas—religious, social, educational—in representative prose writers of the late sixteenth century and of the seventeenth century (Hooker, Bacon, Burton, Browne, Milton, Dryden, and others) in relation to literary theory and practice. 1 unit. BARKER.

417. **Studies in Seventeenth-Century Poetry and Milton (1600-1640).** 1 unit. BARKER.

418. **Studies in Seventeenth-Century Poetry and Milton (1640-1700).** Continuation of English 417. 1 unit. Prerequisite: English 417. BARKER.

421. **Studies in Eighteenth-Century Literature, I.** 1 unit.

422. **Studies in Eighteenth-Century Literature, II.** Continuation of English 421. 1 unit.

423. **Studies in the Eighteenth-Century Novel.** 1 unit. MCBURNEY.

427. **Studies in the Romantic Movement, I.** 1 unit. GETTMANN.

428. **Studies in the Romantic Movement, II.** Continuation of English 427. 1 unit. GETTMANN.

431. **Studies in Victorian Literature, I.** 1 unit. SMALLEY.

432. **Studies in Victorian Literature, II.** Continuation of English 431. 1 unit. SMALLEY.

433. **Major Movements in Modern British Poetry and Drama.** A study of important movements, figures, and ideas which shaped the criticism and practice of modern poetry. 1 unit.

434. **Major Movements in Modern British Fiction.** A study of important movements, figures, works, and ideas which shaped the criticism and practice of modern fiction. 1 unit.

437. **Studies in American Literature: 1600 to 1800.** Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor. DAVIDSON.

438. **Studies in American Literature After 1800.** A course which investigates literary movements, major writers, and intellectual and cultural ideas in American literature from 1800 to the present. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: Survey course in American literature or consent of instructor. DAVIDSON.

441. **Studies in Literary Theory.** The analysis, in accordance with aesthetic principles, of major documents in the history of poetics in order to formulate the central problems of literary theory and to examine proposed solutions to them. 1 unit.

442. **Studies in Recent Literary Theory.** The analysis of representative critics and critical schools of the twentieth century; similarities and differences between them and older critics in the solutions proposed to the central problems of literary theory. 1 unit.

445. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship. Required of all candidates for the degree of Doctor of Philosophy in English. ¼ unit.

446. **Introduction to Advanced Graduate Study.** A consideration of the methods and objectives of literary criticism and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. ¼ unit.

447. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. HOOK.

448. **Literary Analysis for Teachers of English.** An examination of the theoretical considerations underlying various approaches to teaching literature at the high school and introductory college level. 1 unit. Prerequisite: Teaching experience at secondary or college levels.

450. **Problems in Bibliographical Method.** Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor. EVANS.

457. **Problems in Medieval Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. 1 unit.

458. **Problems in Sixteenth-Century Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 411, 412, or equivalent; or consent of instructor.

461. **Problems in Spenser.** A study of special problems relating to the works of Edmund Spenser, his background in England and in Ireland, and the second half of the sixteenth century. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: English 326 or any course on the sixteenth century.

462. **Problems in Tudor Drama.** 1 unit. HOLADAY.

463. **Problems in Shakespeare.** 1 unit. EVANS.

464. **Problems in Elizabethan Drama.** 1 unit. EVANS.

466. **Problems in Seventeenth-Century Metaphysical Poetry and Prose.** Literary technique in relation to intellectual and religious problems in the poetry and prose of John Donne, his contemporaries and successors. 1 unit. Prerequisite: English 345 or 417, or consent of instructor.

467. **Problems in Milton and His Age.** 1 unit. Prerequisite: English 342 or 418 or consent of instructor. BARKER.

471. **Problems in Eighteenth-Century Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 421, 422, or equivalent; or consent of instructor. HAIG.

476. **Problems in Romantic Literature.** A conference and research course concerning special problems, literary movements, and writers of the English Romantic period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 427 and 428, or consent of instructor. STILLINGER.

478. **Problems in Prose Fiction.** 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Second-year graduate standing. GETTMANN.

479. **Problems in Victorian Literature.** Prerequisite: English 431 or 432 or consent of instructor. 1 unit. SMALLEY.

480. **The English Novel in Transition, 1890-1914.** An examination of the works of principal Edwardian novelists, chiefly John Galsworthy, Arnold Bennett, and H. G. Wells, in terms of the transition of the English novel from Victorian to modern. 1 unit.

484. **Problems in Twentieth-Century English Literature.** A conference and research course devoted to selected writers and critical movements of the period. 1 unit. Prerequisite: English 433 or consent of instructor.

486. **Problems in American Criticism and American Culture.** Papers and discussions on literary critics and historians who have used literature as an index to the problems of American culture, 1900-1959. 1 unit. Prerequisite: English 376. PAUL.

488. **Problems in American Literature and Cultural History.** 1 unit. This course may be repeated for a total of two units. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN.

491. **Research in Special Topics.** Research in selected topics by arrangement with the instructor. This course may be repeated for a total of two units. 1 unit.

497. **Independent Reading.** A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrently with a 300-level course. No student may offer more than a total of 1/2 unit of English 497. Prerequisite: Consent of instructor of requisite 300-level course. 1/4 unit.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. BARKER, BERRY, CAMPBELL, DAVIDSON, EVANS, FLANAGAN, GETTMANN, HAIG, HARKNESS, HOLADAY, HOOK, KELLEY, LYNEN, MCBURNEY, MILLET, MILLIGAN, PAUL, SCOTT, SHATTUCK, SMALLEY, STILLINGER, STILLWELL, TYLER, WILSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Same as General Engineering 304. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. DAVIS, MCCLINTOCK.

311. **Chaucer.** 3/4 unit. STILLWELL.

316. **American Drama from 1900 to 1960.** A survey of American dramatic literature of the twentieth century, including the reading of a large number of plays which illustrate the diversity and importance of modern American drama. Special attention is given to the work of Maxwell Anderson and Eugene O'Neill. 3/4 unit. FLANAGAN.

325. **English Literature from 1500 to 1660.** Survey of English literature of the Renaissance, exclusive of Milton and the drama. 3/4 unit. MILLIGAN.

326. **Spenser and His Contemporaries.** A study of the principal preoccupations and forms of Elizabethan poetry, with special reference to Spenser. 3/4 unit, Prerequisite: Six hours of English literature.

336. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. 3/4 unit.

338. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. 3/4 unit.

339. **Comedy.** The history and theory of comic drama. 3/4 unit. SHATTUCK.

340. **Satire.** Comparative study of the chief nondramatic satires of Western civilization, from Roman times to the present. Particular emphasis is given to the bearing these works and traditions have on English satire. 3/4 unit. Offered in 1966-1967 and in alternate years.

342. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. 3/4 unit.

345. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughn, Crashaw), with special emphasis on the poetry of John Donne. 3/4 unit. EVANS, MILLIGAN.

346. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. ¾ unit. EVANS.

348. **Swift, Pope, and Fielding.** A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. Written reports and extensive readings. ¾ unit. Prerequisite: A course in English literature. HAIG.

349. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan; the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. ¾ unit. HAIG.

351. **The Mid-Victorian Novel.** Thackeray, Emily Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. ¾ unit. SCHNEIDER.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. ¾ unit. DAVIDSON, PAUL.

354. **Studies in Middle Western Literature, II.** A survey of Middle Western literature from 1900 to the present, with special emphasis on the development of realism in poetry and fiction. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

359. **The Origin and Development of the Folk Tale.** A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various countries (India, Greece, Norway, Ireland, Germany, Japan, and Africa) are analyzed, and North American Negro and Indian tales are discussed within this larger frame of reference. The semester's work concludes with an examination of folk motifs in the work of such American writers as Hawthorne, Poe, Melville, Twain, Faulkner, and others. ¾ unit. FLANAGAN.

360. **The Popular Ballad and the Folk Song in the United States.** A study of the British and Scottish popular ballad—the Child ballad as it is familiarly known—as it developed in Great Britain and as it was transplanted to the United States, with special emphasis on the development of native American ballads and songs. ¾ unit. FLANAGAN.

362. **The Art of the Lyric.** A study of lyric poetry as a genre. The examination of the nature of lyric convention and lyric originality through the reading of a body of related poems with special attention to the poetic manifestation of language and metaphor. ¾ unit.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as Speech 371. ½ or 1 unit.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as Speech 372. ½ or 1 unit.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. ¾ unit. KELLEY.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. ¾ unit. Prerequisite: English 113 and 114 or English 255 and 256. PAUL.

377. **Major American Poets.** A study of Poe, Whitman, Dickinson, Frost, Eliot, and Cummings with emphasis upon critical interpretation of their writings and the kinds of literary form characteristic of them. ¾ unit. Prerequisite: A course in English or American literature. LYNEN.

378. **Modern American and British Fiction in Its European Background.** A study of the interrelationship between certain themes and techniques in the development of the contemporary American, British, and European novel (from Dostoevsky, Melville, and Conrad through Mauriac, Dos Passos, Kafka, Gide, Faulkner, and Sartre to the present day). ¾ unit. Prerequisite: Two college-level literature courses.

380. **Mark Twain and the Rise of Realism.** A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. ¾ unit. Prerequisite: English 114 or 256, or consent of instructor. SCOTT.

381. **Themes and Movements in British Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. Prerequisite: Six hours of English or American literature.

382. **The Plays of Bernard Shaw.** ¾ unit. SHATTUCK

384. **Comparative Studies in Twentieth-Century Poetry.** A study of contemporary poetry in English in its relationship to modern European verse. The poets studied may vary each time the course is offered. ¾ unit. Prerequisite: Three hours in either poetry or modern literature, or consent of instructor.

385. **Themes and Movements in American Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. ALTENBERND, HODGINS.

387. **The Structure of English.** Same as Linguistics 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit.

Rhetoric and Composition

COURSES FOR GRADUATES

400. **Verbal Communication in English as a Second Language for Graduate Foreign Students, I.** A language laboratory course concentrating on the typical writing problems that a graduate or research student encounters in an American university. No graduate credit. Prerequisite: Rhetoric 111 or consent of instructor.

401. **Verbal Communication in English as a Second Language for Graduate Foreign Students, II.** A language laboratory course dealing with individual, immediate, and specialized speaking and writing problems, with particular attention to orienting the graduate student to the techniques of the American university in thesis and other specialized writings and in the oral presentation of such material. No graduate credit. Prerequisite: Rhetoric 400 or consent of instructor.

480. **The Theory and Practice of English Composition.** An examination of modern prose style and consideration of problems confronting writers and teachers of writing at the college and high school levels. ½ unit. HOOK, MOAKE, WILSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

330. **The Writing of Poetry.** The practice of the writing of poetry, aided by intensive study of examples. ¾ unit. Prerequisite: Six hours of English or American literature, or consent of instructor.

388. **Linguistics in Language Learning, I.** Same as Linguistics 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language or equivalent; consent of instructor.

389. **Linguistics in Language Learning, II.** Same as Linguistics 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguisticis, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Rhetoric 388.

ENTOMOLOGY

See descriptions and course listing under Life Sciences, page 221.

EXTENSION EDUCATION

This program leads to the professional degree of Master of Extension Education and is open to persons holding a bachelor's degree in agriculture, home economics, or a closely related area. Admission to the program requires a grade-point average of at least 3.5 for the last sixty semester hours of undergraduate work.

Candidates are required to complete a minimum of eight units, and nine units are required if a thesis is not submitted. Three of these units must be in 400-level courses with one unit in the major field. A major (four units) may be taken in agriculture, home economics, or the social sciences. Students majoring in agriculture or home economics select four additional units from the social sciences; those majoring in the social sciences select four additional units from agriculture or home economics. All courses selected must be approved by the student's adviser. If a thesis is not submitted, the ninth unit may be selected in any area approved by the adviser. Students majoring in home economics must take work in three of the four major divisions of the department, unless proficiency in one or more of the areas is demonstrated by examination. At least four units must be earned in residence on the Urbana campus. Total extramural credit can not exceed three units.

Inquiries concerning the Master of Extension Education should be directed to Professor Ernest W. Anderson, 116 Mumford Hall.

FINANCE

The Department of Finance offers graduate work leading to the Master of Science and Doctor of Philosophy in Finance. The following fields are available for specialization within the department: money, credit, and banking; corporation finance; corporation history; investment; insurance; urban land utilization.

The grade-point average required for admission to graduate study in the department is 3.75, although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis. A candidate for a degree in finance must also meet the general admission requirements of the Graduate College. He must also have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

A candidate for the Doctor of Philosophy must pass a preliminary examination. Graduate study in accountancy or statistics, or both, is advised strongly for doctoral candidates majoring in finance.

The Doctor of Philosophy program for the first year must include (1) two units of economic theory, (2) four units of finance, and (3) two additional units in finance or related fields. Two of the finance units should be in thesis research. The second year of study includes eight units which provide (1) a concentration in finance, (2) understanding of one or more fields in economics in addition to economic theory, and (3) proficiency in any other related minor field offered.

GRADUATE FACULTY

Professors: P. M. Van Arsdell (Head of Department), C. T. Arlt, R. W. Mayer, R. I. Mehr, R. C. Osborn.

Associate Professors: T. E. Cammack, R. A. Hedges, A. J. Heins, J. W. Leonard.

Assistant Professors: J. J. Dasso, J. R. Pike.

COURSES FOR GRADUATES

420. **Central Banking Policy.** An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. 1 unit. Arlt.

425. **The Money Market and Financial Stabilization.** A study of interest rate determination; the structure and operations of the money and capital markets; the objectives and implementation of monetary, fiscal, and debt management policies. 1 unit. Prerequisite: Finance 150. Arlt.

427. **Commercial Bank Management.** A study of the principal policies and problems which confront top management. Major emphasis is given to liquidity, loans, investments, deposits, and capital funds, but consideration is also given to bank statements, organization structure, operations, personnel, cost analysis, and public relations. Instructional methods utilize readings, cases, and research projects. 1 unit. Prerequisite: Finance 150. Heins.

454. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. 1 unit. Prerequisite: Finance 254. Van Arsdell.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. 1 unit. Prerequisite: Finance 254. Van Arsdell.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investment, on a critique of investment policy, and on the valuation of investment media. 1 unit. Mayer.

460. **Theory of Insurance.** A study of the nature and cost of risk in our economic society and of the methods of handling it. 1 unit. Mehr.

490. **Individual Study and Research.** Directed reading and research. ½ to 1 unit. Staff.

499. **Thesis Research.** Required for those writing master's and doctor's theses in finance. 0 to 4 units. Mayer.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **Consumer Finance.** Nature and importance of consumer finance; trends in consumer credit; instruments and institutions of consumer credit; economic effects of consumer finance; consumer credit and public policy. ½ to 1 unit. Extra work is required of graduate students who register for 1 unit. Prerequisite: Finance 150 and 254, or consent of instructor.

357. **Financing Small Business.** Size and nature of small business; significance and limitations of small business; financial structure and problems; financial assistance to small business; future prospects of small business. ½ to 1 unit. Prerequisite: Finance 254 or 257. Osborn.

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities,

of senior securities with speculative features, of common stocks, of government and municipal securities, and of investment company securities. ½ to 1 unit. Prerequisite: Accountancy 108; Finance 254. MAYER.

360. **Group Insurance and Pensions.** Same as Labor and Industrial Relations 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 248. MEHR.

363. **Estate Planning.** A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. ½ to 1 unit. Prerequisite: Finance 262. MEHR.

368. **Survey of Urban Real Estate.** A board survey of the field of real estate and urban land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor.

369. **Urban Land Problems.** A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for individual study. Whenever possible the problems are selected and developed jointly with the departments of Urban Planning, Landscape Architecture, Architecture, and others. ½ to 1 unit. Prerequisite: Finance 368 or consent of instructor.

370. **Risks and Risk Management.** Analysis of the financial problems in the risks of property damage or bodily injury in business situations and evaluation of the alternative methods for dealing with such problems. ½ to 1 unit. Prerequisite: One of the following: Accountancy 105 or 201; Economics 103 or 108; Finance 254 or 257. HEDGES.

FOOD SCIENCE

(Including Dairy Technology)

The Department of Food Science offers graduate work leading to the Master of Science and Doctor of Philosophy in either Food Science or Dairy Technology. The grade-point average required for admission to graduate study is 3.75, although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis.

To obtain a graduate degree in food science, a student must have credit (graduate or undergraduate) in Chemistry 350 and 355, Microbiology 311 and 312, Food Science 301, 302, 421 (M.S., one-fourth unit; Ph.D., one-half unit), and 499 (M.S., two units; Ph.D., eight units).

Doctor of Philosophy. Candidates for the Doctor of Philosophy should complete formal course work and satisfy the language requirements (German, and French or Spanish) by the end of the second year of residence so that a minimum of one year may be spent in research. Each candidate must take a comprehensive written examination before the oral preliminary examination for the doctorate.

Graduate credit courses offered outside the Department of Food Science may be applied in partial satisfaction of the major unit requirements. These may be selected from closely related fields of study, such as microbiology, chemistry, physics, engineering, and applied biological sciences, and are subject to the approval of the major department. Minors may be selected from these same fields as well as from economics and management.

Second-year and third-year graduate students are expected to attend all seminars (Dairy Technology 404) in dairy technology, but they can register for a maximum of only one-half unit of credit. Dairy Technology 403, Agronomy 440, and Dairy Technology 499 (eight units) are also required for the Doctor of Philosophy.

A student planning to take a major or minor in food science should have a Bachelor of Science in a recognized field of biological, physical, agricultural, or engi-

neering science in which a minimum of the undergraduate credits are as follows: biology, six hours; physics, eight hours; calculus, five hours; microbiology, five hours; analytical chemistry, five hours; organic chemistry, five hours; physical chemistry, four hours; and food science or equivalent, twenty hours.

Master of Science. To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350 and 355, Dairy Technology 401 (one unit), 404 (one unit), and 499 (two units). A course in statistics is also necessary unless such a course was taken by the student when an undergraduate. The remainder of the eight units required for the Master of Science can be taken in the major and minor fields.

Research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing.

Candidates for the master's degree must complete one language requirement (German, French, or Spanish) and one minor and are required to take an examination covering the field of general food science and of their specialization. The candidate must present a thesis unless this requirement is waived by petition to the department.

GRADUATE FACULTY

Professors: R. T. Milner (Head of Department), E. O. Herreid, L. B. Howard, F. A. Kummerow, A. I. Nelson, Z. J. Ordal, M. P. Steinberg, J. Tobias, S. L. Tuckey, R. M. Whitney.

Associate Professors: T. Nishida, H. K. Wilson, L. D. Witter.

Assistant Professors: C. Argoudelis, K. A. Narayan, E. G. Perkins, L. Wei.

Food Science

COURSES FOR GRADUATES

404. **Special Topics in Food Science, III: Technology of Fats and Oils.** A study of the commercial technology of fats and oils, including soaps and protective coating. Offered in 1966-1967 and in alternate years. ½ unit. Prerequisite: Food Science 391 or consent of instructor. Narayan.

406. **Special Topics in Food Science, IV: State and Metabolism of Lipids.** An advanced study of the state of lipids in animal tissues and in biological fluids, and of the metabolism of lipids in relation to dietary fats and other food constituents. Offered in 1966-1967 and in alternate years. 1 unit. Prerequisite: Chemistry 350 or consent of instructor. Nishida.

421. **Seminar.** Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food science. ¼ unit. Staff.

430. **Carbohydrates in Foods.** Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 355, 354, or 350, or consent of instructor.

481. **Advanced Studies in Food Science.** Library or laboratory assignments on specific problems of limited scope involving individual commodities or processes. ½ to 2 units. Staff.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, dehydrating, and fermenting methods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Food Science 201 or equivalent. Nelson, Wei.

302. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; vacuum and freeze drying of foods; evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Food Science 202 and 301, or equivalent. NELSON, WEI.

332. **Principles of Sanitation in the Processing and Handling of Foods.** A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and micro-organisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulation. Local field trips to food processing plants. ½ unit. Prerequisite: Microbiology 100 and 101 and Chemistry 132, or equivalent. ORDAL, WITTER.

363. **Introduction to Process Engineering.** Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Chemistry 340 or 342; one year of calculus; or consent of instructor.

373. **Advanced Food Microbiology.** A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. 1¼ units. Offered in 1967-1968 and in alternate years. Prerequisite: Chemistry 133: Microbiology 311 and 312. ORDAL, WITTER.

391. **Special Topics in Food Science, I: Chemistry of Lipids in Foods.** A detailed survey of the chemical and physical properties of lipids. Offered in 1966-1967 and in alternate years. ½ unit. Prerequisite: Credit or registration in Chemistry 350, or consent of instructor. PERKINS.

393. **Special Topics in Food Science, II: Experiments in Lipid Chemistry.** Laboratory exercises, demonstrations, and assigned readings. Offered in 1966-1967 and in alternate years. ½ unit. Prerequisite: Registration in Food Science 391 or consent of instructor. ARGOUDELIS.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy Technology.** Study of fundamentals and fundamental problems involved in the processing of milk and milk products. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Chemistry 350. HERREID.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. WHITNEY.

404. **Seminar.** Review of current literature in dairy technology. Students may register for credit only twice for a maximum of one-half unit. ¼ unit. STAFF.

491. **Assigned Problems in Dairy Technology.** Research on special problems for graduate students with a major interest in dairy technology. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Dairy Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. ½ unit. Prerequisite: Consent of instructor. WILSON.

310. **Dairy Product Processing.** Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, dried milk, and ice cream. 1 unit. Prerequisite: Food Science 201; Dairy Technology 211; credit or registration in Dairy Technology 213. HERREID.

311. **Dairy Product Processing.** Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, casein, lactic acid, lactose, and fermentation products of whey. 1 unit. Prerequisite: Dairy Technology 211 and 213. TUCKEY.

312. **The Chemistry of Milk and Milk Products.** Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. Offered in 1966-1967 and in alternate years. ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 213 or Chemistry 122. WHITNEY.

FORESTRY

The Department of Forestry offers graduate work leading to the degree of Master of Science in Forestry to graduates of forestry curricula substantially equivalent, in scope and standards, to those of the University of Illinois. The minimum grade-point average for admission to graduate study is 3.75. The program is intended for the forestry graduate who desires to deepen his understanding of the scientific principles which underlie some particular phase of forestry, such as forest ecology, economics, genetics, management, mensuration, protection, or soils; or aerial photointerpretation and wood technology.

In consultation with his adviser, a student plans a program which meets the general requirements of the Graduate College and serves his particular needs and interests. Such a program must include a seminar in forestry and, in most instances, original research and the presentation of a thesis on an appropriate problem. The thesis requirement may be waived only if, in the judgment of the departmental graduate committee, such waiver will result in a better program in a specific case. Advanced courses related to the student's special interest are found in such areas as biometrics, botany, climatology, economics, entomology, genetics, mathematics, photogrammetry, plant pathology, and soil science (see departmental listings).

A candidate must earn eight units of graduate credit, with at least three units in courses at the 400 level. He must also pass an oral examination covering the general field of forestry and the area of his specialization.

GRADUATE FACULTY

Professors: T. E. AVERY (Head of Department), W. R. BOGGESS, I. I. HOLLAND, C. S. WALTERS.

COURSES FOR GRADUATES

400. **Seminar.** Discussions on specialized topics and current literature in forestry. Required of all graduate students in forestry. ¼ unit. May be taken twice for a total credit of one-half unit. STAFF.

401. **Special Problems.** Individual studies or investigations in selected branches of forestry. ½ to 1 unit. Not more than one unit may be offered for an M.S. degree. STAFF.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. CARMER.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Forestry 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Forestry 440 or equivalent. CARMER.

499. **Thesis Research.** Research may be conducted in various phases of forestry. Subject must be approved by departmental committee. 1 to 3 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Forest Soils.** Soil factors related to forest hydrology and tree growth. Students take a two-week field trip, with students from Forestry 213, to southeastern states; estimated expense, $65.00. Graduate students are required to attend a special seminar. ½ unit. Prerequisite: Agronomy 101 and Forestry 212; or graduate standing in botany with Botany 381 or equivalent. BOGGESS.

362. **Forest Entomology.** A study of the characteristics, life histories, and forest relationships and controls of the economically important forest insects of the United States. ½ unit. Prerequisite: One year of biological science; one year of chemistry. RENNELS.

FRENCH

The Department of French offers graduate work leading to the Master of Arts, Master of Arts in the Teaching of French, and Doctor of Philosophy.

Students are admitted with a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Students electing French as a major subject should have had a college major in French, including practical work in the use of the language and advanced work in literature. Some knowledge of other Romance languages and literatures is desirable. A basic knowledge of Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates must pass an examination based on a general reading list. Candidates preparing to teach French must take French 311, 313, and 314 unless they can demonstrate proficiency.

Doctor of Philosophy in French. Candidates are expected to take at least two units in seminar courses. Candidates also are required to include French 475 and 476, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject. French 406 also is required.

Master of Arts in the Teaching of French. Candidates for the Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 311, 313, 314, two units; two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields.

GRADUATE FACULTY

Professors: B. H. MAINOUS (Head of Department), J. D. HUBERT, RENÉE HUBERT, F. JOST, C. A. KNUDSON, P. KOLB, C. P. VIENS.

Associate Professors: S. E. GRAY, E. JAHIEL, F. W. NACHTMANN.

Assistant Professors: BARBARA C. BOWEN, V. E. BOWEN, H. DELEY, F. M. JENKINS, J. K. SIMON.

COURSES FOR GRADUATES

400. **Beginning French for Graduate Students.** Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit.

401. **Reading French for Graduate Students.** Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

405. **Teaching College French.** A study of the problems of teaching French at the college level, including classroom procedures and language laboratory techniques. No credit.

406. **Research Methods.** Orientation in graduate research, introduction to bibliographical problems, and survey of methodology for papers and dissertations. ¼ or ½ unit. V. E. BOWEN.

Note: In any given year a selection from the following courses is offered. For current information, consult the department office or the current semester Time Table.

407. **French Literary Criticism, I: History of French Literary Criticism from the Sixteenth to the Twentieth Centuries.** Literary theory and practice of criticism as developed in France from the sixteenth to the twentieth centuries. Analysis and discussion of preoccupations, critical methods, and approaches to literature of representative critics, with emphasis upon emergence of philosophies of criticism. 1 unit.

408. **French Literary Criticism, II: Studies in Recent French Criticism.** Study of important trends in French literary criticism of the mid-twentieth century, relating these trends to critical problems and theories of literature of the late nineteenth century and the earlier part of the twentieth. 1 unit.

421. **Literature of the French Renaissance.** Discussion and analysis of some of the more important intellectual and religious preoccupations of the sixteenth century, as reflected in representative texts by important writers of the period. 1 unit.

424. **Studies in French Poetry.** Versification, poetic structure, problems of imagery and meaning, and practical work in the interpretation of individual poems. 1 unit. GRAY, J. D. HUBERT.

425. **Explication de textes, I.** Exercises according to the method of *explication de textes,* applied to texts selected principally from the period 1944-1958. 1 unit.

426. **Explication de textes, II.** The French method of *explication de textes* applied to selected texts of the principal French writers, in particular the *penseurs et essayistes.* 1 unit.

431. **History of Old French Literature, I.** Lectures on the history of French literature from the eleventh through the fifteenth century, with illustrative reading in translation. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Graduate standing in French or related department. KNUDSON.

432. **History of Old French Literature, II.** 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Graduate standing in French or related department. KNUDSON.

433. **Villon, Rabelais.** 1 unit. Offered in 1967-1968 and in alternate years. B. BOWEN.

434. **Montaigne, La Pleiade.** 1 unit. Offered in 1966-1967 and in alternate years. B. BOWEN.

435. **Seventeenth-Century Literature, I.** 1 unit. Offered in 1967-1968 and in alternate years. J. D. HUBERT.

436. **Seventeenth-Century Literature, II.** 1 unit. Offered in 1967-1968 and in alternate years. J. D. HUBERT.

437. **Eighteenth-Century Literature, I.** 1 unit. Offered in 1966-1967 and in alternate years. V. Bowen, Jost.

438. **Eighteenth-Century Literature, II.** 1 unit. Offered in 1966-1967 and in alternate years. V. Bowen, Jost.

447. **Nineteenth-Century Literature to 1850, I.** 1 unit. Offered in 1966-1967 and in alternate years.

448. **Nineteenth-Century Literature to 1850, II.** 1 unit. Offered in 1966-1967 and in alternate years.

453. **French Realism and Naturalism, I.** 1 unit. Offered in 1967-1968 and in alternate years.

454. **French Realism and Naturalism, II.** 1 unit. Offered in 1967-1968 and in alternate years.

457. **Seminar in Proust, I.** ½ unit. Offered in 1966-1967 and in alternate years. Kolb.

458. **Seminar in Proust, II.** ½ unit. Offered in 1966-1967 and in alternate years. Kolb.

459. **Seminar in Modern French Literature, 1870 to 1935.** An intensive study of one or two authors of the late nineteenth and early twentieth centuries. Authors who may be studied include the Parnassian or Symbolist poets and the following novelists: Barrès, Bourget, Anatole France, Loti, Gide, Martin du Gard, Duhamel, Mauriac, Giraudoux. 1 unit. Students may receive credit more than once. J. D. Hubert, R. Hubert, Jahiel, Kolb.

460. **Seminar in French Literature.** Discussion and research on some specialized area in French literature. Topic will be announced in advance. Course may be repeated for credit. 1 unit. Gray, Jost.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

463. **La Poésie Symboliste.** An intensive study of two of the following major poets: Nerval, Baudelaire, Rimbaud, Mallarmé. 1 unit. R. Hubert.

464. **Du Cubisme au Surréalisme.** A study of the poetic and theoretical writings of Apollinaire, Reverdy, Jacob, Breton, and Eluard. 1 unit. R. Hubert.

465. **La Littérature Contemporaine, I.** In French. Twentieth-century poets and novelists. 1 unit. Offered in 1966-1967 and in alternate years. Gray, R. Hubert, Simon.

466. **La Littérature Contemporaine, II.** 1 unit. Offered in 1966-1967 and in alternate years. Gray, R. Hubert, Simon.

475. **Old French Philology, I.** Reading of characteristic masterpieces of medieval French literature and study of the development of the Old French language from Latin. 1 or 1¼ units. Offered in 1966-1967 and in alternate years. Prerequisite: Consent of instructor; elementary knowledge of Latin; reading knowledge of German. Knudson.

476. **Old French Philology, II.** 1 or 1¼ units. Offered in 1966-1967 and in alternate years. Prerequisite: French 475. Knudson.

491. **Individual Topics.** ¼ to 1 unit. Staff.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The prerequisite for all courses in this group is French 201 and 202, or equivalent.

309. **Survey of French Literature, I.** ¾ or 1 unit.

310. **Survey of French Literature, II.** ¾ or 1 unit.

311. **Diction Française.** Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course

and French 313 be taken concurrently. ½ unit. Prerequisite: Consent of instructor. VIENS.

313. **Phonétique de la Langue Française.** A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 311 be taken simultaneously. ¾ unit. Prerequisite: Consent of instructor. JENKINS, MYERS.

314. **Syntaxe Française Avancée.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. ¾ unit. Prerequisite: Consent of instructor.

316. **Structure de la Langue Française.** A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313 or equivalent training in phonetics. JENKINS.

317. **Le Théâtre Français Depuis 1800, I.** ¾ unit. Offered in 1966-1967 and in alternate years. JAHIEL.

318. **Le Théâtre Français Depuis 1800, II.** ¾ unit. Offered in 1966-1967 and in alternate years. JAHIEL.

323. **Littérature du Dix-Septième Siècle, I.** Major writers of the pre-classical period. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: French 201 and 202, or equivalent. DELEY, J. HUBERT.

324. **Littérature du Dix-Septième Siècle, II.** Major writers of the classical period. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: French 201 and 202, or equivalent. DELEY, J. HUBERT.

327. **La Littérature Française du Dix-Huitième Siècle, I.** Montesquieu, Voltaire, and their contemporaries. ¾ unit. Prerequisite: French 201 and 202, or equivalent. V. BOWEN.

328. **La Littérature Française du Dix-Huitième Siècle, II.** Diderot, Rousseau, and their contemporaries. ¾ unit. Prerequisite: French 201 and 202, or equivalent. V. BOWEN.

331. **Le Roman Français du Dix-Neuvième Siècle, I.** From Balzac to Proust. ¾ unit. Offered in 1967-1968 and in alternate years. R. HUBERT, KOLB.

332. **Le Roman Français du Dix-Neuvième Siècle, II.** From Balzac to Proust. ¾ unit. Offered in 1967-1968 and in alternate years. R. HUBERT, KOLB.

333. **La Littérature Contemporaine, I.** In French. Modern poetry from Baudelaire to Valéry. Prose writers from 1900 to 1940. Offered in 1967-1968 and in alternate years. ¾ unit. GRAY.

334. **La Littérature Contemporaine, II.** Offered in 1967-1968 and in alternate years ¾ unit. GRAY.

335. **Civilisation Française, I.** In French. A survey of French life and French institutions, intended as a background for literary studies and as a preparation for the teaching of French. ¾ unit. MAINOUS.

336. **Civilisation Française, II.** ¾ unit. MAINOUS.

382. **Language Laboratory Techniques.** Same as German, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS.

GENERAL ENGINEERING

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE FACULTY

Professors: J. S. Dobrovolny (Head of Department), S. G. Hall, B. O. Larson, E. C. McClintock, J. E. Pearson.
Associate Professor: F. L. Spalding.
Assistant Professor: R. J. Placek.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Same as English 304. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. McClintock.

313. **Advanced Methods in Engineering Graphical Computations.** Application of determinants in the theory and construction of engineering nomograms; curve fitting and formulation of empirical formulae; methods and application of graphical calculus. ½ to 1 unit. Prerequisite: Mathematics 142 or equivalent. Placek.

330. **Industrial Standardization.** Evolution and history of standardization; local, national, and international standardization; governmental standardization. Special emphasis is placed on standardization procedures for individual industrial establishments. ½ unit. Prerequisite: Consent of instructor. Spalding.

360. **Engineering Applications of Meteorological Fundamentals.** The application of the fundamentals of meteorology to engineering problems including the transport and diffusion of particulate matter, aerosols, and gases; precipitation processes and rainout; behavior of stack effluents, explosion debris, and radioactive materials in the atmosphere. Applications to operation scheduling and to site selection. 1 unit. Prerequisite: Mathematics 142 or 143; Physics 106, 107, and 108; Mechanical Engineering 205 and 206, or 209, or Chemistry 342 and 344, or Physics 360. Pearson.

393. **Special Problems.** Study of advanced problems related to general engineering and graphics. ½ to 1 unit. Prerequisite: Consent of instructor. Larson, Staff.

GENETICS

A Doctor of Philosophy program in genetics is provided through the cooperative efforts of eight different departments of biology and is administered by the University Committee on Genetics. Training in biochemical genetics, cytogenetics, and population genetics of a variety of organisms is provided. Students seeking master's degrees are directed to the various departmental programs, or to the master's program in biology offered by the School of Life Sciences.

Applicants for admission should have at least a 4.0 grade-point average for the last sixty hours, but may be considered for admission with a 3.75 average. They should also have completed one year of college physics, quantitative and organic chemistry, trigonometry, and analytic geometry. Calculus is strongly recommended. During the first calendar year of graduate study, students are required to take an advisory examination in the major genetic areas.

During the first two years, candidates should complete courses or demonstrate proficiency in biological chemistry (Chemistry 350, 355), calculus (Mathematics 132, 142, or 133, 143), statistics (Mathematics 363 or Agronomy 440), cytology (Botany 420), cytogenetics (Botany 421), population genetics (Animal Science or Dairy Science 411, or Zoology 407), and microbial genetics (Microbiology 330). All programs of study must be approved by the Genetics Committee. Students wishing a sole minor in genetics are required to complete four units of work in areas approved by the Committee and including at least ¾ unit in a 400-level course outside the major area.

Students majoring in genetics ordinarily elect minors in one of the biology departments and in either chemistry or mathematics. Students in the genetics program are eligible for fellowships and assistantships in the participating departments and should indicate their departmental preference (Agronomy, Animal Science, Botany, Dairy Science. Horticulture, Microbiology, Psychology, or Zoology) when applying for admission.

Thesis research may be carried out under the direction of appropriate staff members in the participating departments under departmental course listings. Inquiries concerning the program should be directed to the Chairman of the Genetics Committee. Professor David L. Nanney, 220 Burrill Hall.

GEOGRAPHY

The Department of Geography offers work leading to the Master of Arts, Master of Science, and Doctor of Philosophy. The systematic specializations of the department are: theoretical and applied area development, regional geography, and physical-ecological geography.

Students applying for admission must have a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All candidates for advanced degrees in geography must have an average of at least 4.25 in previous work in geography.

Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose backgrounds are largely in physical geography are recommended for the Master of Science; others receive the Master of Arts.

At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the departmental graduate committee. Students must have had, either as undergraduates or as graduates, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of a University of Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political science, sociology, or anthropology are recommended in the social sciences.

Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are geography electives, two units in education, and two units in electives. Requirements are Geography 495, two units; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. Two electives must be in geography and the other two in geography, education, or, in exceptional cases, other fields. The grade-point average required for admission is 3.5. The adviser for candidates for this degree is Professor J. H. Garland, 224 Davenport Hall.

Doctor of Philosophy. The doctoral student is expected to penetrate deeply into specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for this degree must have taken, either as undergraduates or as graduates, all work required in the undergraduate major and the master's and doctor's programs of the department or the equivalent.

Admission to candidacy for the Doctor of Philosophy in geography is recommended after the successful completion of:

(1) At least sixteen units of graduate credit, or equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography. The department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology; the other in an-

thropology, economics, history, political science, sociology, Latin American studies, or Russian studies. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination.

After being admitted to candidacy for the Doctor of Philosophy, the student must complete a research thesis, eight units of Geography 499, which normally requires field investigation.

GRADUATE FACULTY

Professors: A. W. Booth (Acting Head of Department), J. D. Fellmann, F. W. Foster, J. H. Garland, H. G. Roepke, J. A. Russell, D. B. Shimkin.

Associate Professors: C. S. Alexander, E. W. Cavins, C. H. Nichols, J. Thompson.

Assistant Professor: R. W. Armstrong.

COURSES FOR GRADUATES

412. **Analytical Climatology.** A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Armstrong.

421. **Regional Concepts in Geography.** Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. ½ unit. Prerequisite: Nine hours of regional geography. Garland.

429. **The Evolution of Agricultural Economies.** Same as Agronomy and Anthropology 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. Alexander, Staff.

461. **Fundamentals of Bioclimatology.** Same as Physiology 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor. Armstrong, Sargent.

462. **Experimental Bioclimatology.** Same as Physiology 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Geography 461. Armstrong, Sargent.

463. **Historical Geography.** Objectives and methods of historical geography. 1 unit. Russell.

464. **Advanced Human Bioclimatology.** Same as Physiology 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Geography 461. Armstrong, Sargent.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. 1 unit. Prerequisite: Geography 373 or consent of instructor. Foster.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. 1 unit. Foster.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. ½ to 2 units. Work may be taken in the following fields:

(a) **Physical Geography, Africa, Agricultural Origins.** ALEXANDER.

(b) **Medical Geography, Australia and New Zealand, Quantitative Geography.** ARMSTRONG.

(c) **Asia, Resource Management, Transportation.** BOOTH.

(d) **Urban Geography, U.S.S.R.** FELLMANN.

(e) **Middle East, Advanced Cartography.** FOSTER.

(f) **Anglo America, Political Geography, Regionalism.** GARLAND.

(g) **Economic Geography, Industrial Location, Europe.** ROEPKE.

(h) **Europe, Marketing Geography.** RUSSELL.

(i) **Human Ecology, U.S.S.R.** SHIMKIN.

(j) **Latin America.** THOMPSON.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. ½ unit. FELLMANN.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the acquisitions, care, and library use of maps. Classes become familiar with the major cartobibliographical and related aids. ½ unit. Prerequisite: Consent of instructor. WHITE.

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. ¾ unit. Prerequisite: Geography 101 and 111. ARMSTRONG.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. ¾ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

323. **Geography of the North American Midwest.** The core of the North American continent; detailed analysis of the functions and patterns of the Midlands and their external relations. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. GARLAND.

332. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. ¾ unit. Prerequisite: Eight hours of geography or enrollment in Latin-American studies program, or consent of instructor. THOMPSON.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. RUSSELL.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and

transportation. ¾ unit. Prerequisite: Eight hours of geography, consent of instructor, or enrollment as a major or minor in Russian language and area studies. FELLMANN.

355. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

357. **Geography of the Middle East and North Africa.** A regional geography of an area with limits largely defined in terms of Arab and Moslem influences or closely related cultural and historical circumstances. The course is oriented around the strategic centrality of the core of the territory as the crossroads of Europe, Asia, and Africa. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. FOSTER.

361. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. ¾ unit. FOSTER.

362. **Geography of Manufacturing.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. ¾ unit. Offered in 1966-1967 and in alternate years. ROEPKE.

363. **Geography of Minerals.** Geographic aspects of the mineral industries. ¾ unit. Offered in 1967-1968 and in alternate years. ROEPKE.

365. **Geography of Transportation.** A consideration of the agents of transportation (land, water, air), the routes of transportation, transportation terminal complexes, and the basic commodity exchange services of transportation within the framework of their regional interregional relationships. ¾ unit. BOOTH.

366. **Location of Industry and Other Economic Activities: Theory and Practice.** Locational theory applied to the relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites. Study of factors affecting location of stores and other commercial activities. ¾ unit. FELLMANN, ROEPKE.

369. **Introduction to Human Ecology.** Same as Anthropology, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Quantitative Methods in Geography.** Geographical applications of statistical and mathematical research techniques. ¾ unit. Prerequisite: Geography 185, or one year of college mathematics, or one course in statistics, or the equivalent. ARMSTRONG.

371. **Introduction to Research.** Introductory training in bibliographical and cartographic techniques as source materials of geographic research. Limited to students whose major is geography and to seniors whose major is in other departments but who have twelve hours of geography. ¾ unit. FELLMANN, STAFF.

372. **Introduction to Research.** Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. ½ unit. STAFF.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. 1 unit. Prerequisite: Consent of instructor. FOSTER.

374. **Problems in Human Ecology.** Same as Anthropology, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Geography, Anthropology, Health Education, Physiology, Sociology, or Zoology 369. SHIMKIN, STAFF.

378. **Descriptive Interpretation of Remote Sensors.** Descriptive interpretation of remote-sensing images with emphasis on interpretation of aerial photography; applications of aerial photography and photographic interpretation to the solution of problems in the major field of the individual student. Two half-day field trips on Saturdays are required. 1 unit. Prerequisite: Consent of instructor. BOOTH.

381. **Russian Culture History and Ethnology.** Same as Anthropology 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. **Siberian Culture History and Ethnology.** Same as Anthropology 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. 1 unit. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; Western Hemisphere nations. ¾ unit. GARLAND.

GEOLOGY

Graduate students may take work in the Department of Geology leading to the Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, mathematics, and in chemistry, physics, or biology rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, geochemistry, geomorphology and glacial geology, mineral deposits, mineralogy and petrology, oceanography, paleontology and stratigraphy, ground-water geology, sedimentation, sedimentary petrography, and submarine geology.

Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, geomorphology, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and mathematics. He may substitute advanced courses in mathematics, chemistry, physics, or the biological sciences for certain geology courses with departmental approval.

A candidate for the doctor's degree may select a minor in chemistry, physics, mining or civil engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

GRADUATE FACULTY

Professors: C. A. Chapman (Acting Head of Department), A. Carozzi, D. U. Deere, J. C. Frye, R. E. Grim, A. F. Hagner, H. W. Scott, P. R. Shaffer, H. R. Wanless, G. W. White.

Associate Professors: R. N. Farvolden, W. W. Hay, D. M. Henderson, R. Langenheim, A. F. Richards, F. M. Wahl.

Assistant Professor: C. J. Mann.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. 1 unit. Offered in 1966-1967 and in alternate years. Wanless.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. 1 unit. Offered in 1967-1968 and in alternate years. Wanless.

403. **History of Geology.** 1 unit.

409. **Sedimentation.** 1 unit. Wanless.

415. **Geology of the Upper Mississippi Valley.** Field study of the geology of Illinois and adjacent states by means of five or six two-day field trips and the preparation of reports; estimated travel expense, $60.00. 1 unit. Langenheim.

420. **Paleoecology.** Interpretation of life habit of fossil organisms from skeletal morphology and associated depositional features; reconstruction of marine ecosystem relations from the study of assemblages of fossils. 1 unit. Prerequisite: Geology 320 or equivalent. Hay.

422. **Stratigraphic Geology: Paleozoic.** 1 unit. Prerequisite: Geology 321. Scott.

423. **Stratigraphic Geology: Mesozoic and Cenozoic.** 1 unit. Prerequisite: Geology 321. Langenheim.

425. **Micropaleontology: Foraminifera.** Classification of microfossils, foraminifera; stratigraphic correlation. 1 unit. Prerequisite: Geology or Zoology 320. Scott.

426. **Micropaleontology: Ostracoda.** Classification of microfossils, ostracods, conodonts, scolecodonts, and other major groups, stratigraphic correlations. 1 unit. Prerequisite: Geology or Zoology 320. Scott.

430. **Crystallography.** A consideration of the approaches and techniques required for an understanding of the structures and properties of crystals, especially those of minerals; emphasis is given to the development of pattern theory, space groups, and their applications. 1 unit. Prerequisite: Geology 335 or equivalent; consent of instructor. Henderson.

431. **Structural Mineralogy.** Principles of the crystal chemistry and structural classification of minerals, and survey of the current knowledge about the structures and structurally dependent properties and behavior of representative minerals and mineral groups. 1 unit. Prerequisite: Geology 430; consent of instructor. Henderson.

432. **Geochemistry.** A chemical approach to the interpretation of geological processes with emphasis on principles which control the distribution and migration of elements in geological environments. 1 unit. Prerequisite: Geology 336 or Chemistry 321, or equivalent; consent of instructor. Wahl.

435. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. 1 unit. Chapman.

436. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied, and special methods of investigation are covered. 1 unit. Chapman.

437. **Sedimentary Petrology.** A study of sedimentary petrogenesis, including erosion, transportation, deposition, consolidation, diagenesis, and lithification. 1 unit. Prerequisite: Geology 335. RICHARDS.

438. **Sedimentary Petrography.** Microscopic study of sedimentary rocks in thin section with emphasis on textures and structures, as a basis for their detailed classification and genetic interpretation. 1 unit. Prerequisite: Geology 335 and 437. CAROZZI.

440. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. 1 unit. HAGNER.

443. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. 1 unit. Prerequisite: Geology 311. HAGNER.

444. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. 1 unit. Prerequisite: Geology 443. HAGNER.

450. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

455. **Hydrogeology.** The geology of the occurrence, storage, movement, and quality of water in the rocks of the Earth's crust. 1 unit. Prerequisite: Consent of instructor. FARVOLDEN.

461. **Mineralogy of Clays.** Same as Ceramic Engineering 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. **Mineralogy of Clays.** Same as Ceramic Engineering 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. GRIM.

471. **Submarine Geology.** General geology of the ocean basins and continental margins, with emphasis on the geological interpretation of marine geophysical investigations. 1 unit. Prerequisite: One year of physics or consent of instructor. RICHARDS.

493. **Advanced Studies in Geology.** ½ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** GRIM, WAHL.
(b) **Engineering Geology.** DEERE, RICHARDS.
(c) **Geomorphology and Glacial Geology.** SHAFFER, WHITE.
(d) **Geotectonics.** CAROZZI.
(e) **Ground-Water Geology.** FARVOLDEN.
(f) **Micropaleontology.** SCOTT.
(g) **Mineral Deposits.** HAGNER.
(h) **Mineralogy and Crystallography.** HENDERSON.
(i) **Paleobotany.** (See Botany 493j.) PHILLIPS, STEWART.
(j) **Paleontology.** HAY, SCOTT.
(k) **Pennsylvanian Stratigraphy.** WANLESS.
(l) **Petrography and Petrology.** CHAPMAN.
(m) **Sedimentary Petrology.** CAROZZI, RICHARDS, WANLESS.
(n) **Stratigraphy.** LANGENHEIM, MANN, SCOTT.
(o) **Oceanography and Ocean Engineering.** RICHARDS.
(p) **Submarine Geology.** RICHARDS.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Geomorphology.** The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. 1 unit. Prerequisite: Geology 102. SHAFFER, WHITE.

311. **Structural Geology.** Rock deformation and its results. Lectures, laboratory, and one two-day field trip. 1 unit. Prerequisite: Geology 102; General Engineering 205 or consent of instructor.

315. **Field Methods.** Mapping of an area in southern Illinois or western Kentucky during Easter vacation. Credit is given only on completion of a satisfactory written report. ½ unit. Prerequisite: Geology 102. KIEFER, WANLESS.

317. **Field Geology in the Rocky Mountains.** Field course conducted from a locality in the Rocky Mountains. Field training in stratigraphy, structure, and geomorphology; geologic mapping with a plane table and aerial photographs. Approximate cost, $325 to $470. S; 2 units. Prerequisite: Geology 102; consent of instructor.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lectures and laboratory. A student may not receive credit for both Geology 222 and 320. 1 unit. Prerequisite: Geology 102. HAY.

321. **Stratigraphy.** Stratigraphy-fossil faunas, with special reference to invertebrates, correlation, and stratigraphy. A student may not receive credit for both Geology 222 and 321. 1 unit. Prerequisite: Geology 320. SCOTT.

324. **Vertebrate Paleontology.** Same as Zoology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Geology 102 or Zoology 132. BADER.

325. **Paleobotany.** Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. STEWART.

335. **Optical Mineralogy.** Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is placed on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. 1 unit. Prerequisite: Geology 132. CHAPMAN.

336. **Petrography.** Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is placed on the ordinary methods of petrographical investigation. 1 unit. Prerequisite: Geology 335. CHAPMAN.

350. **Theoretical Geophysics.** An introduction to the major fields of theoretical geophysics: figure of the earth, thermodynamics of the earth, gravity, seismology, magnetism, and planetary geophysics. 1 unit. Prerequisite: Mathematics through calculus; one year of physics; Geology 311; consent of instructor.

351. **Geophysical Prospecting.** Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor. DE WITTE.

370. **Oceanography.** Principles of biological, chemical, geological, and physical marine science. 1 unit. Prerequisite: Botany 100 or Zoology 104, Chemistry 101, Geology 101, Physics 101; or consent of instructor.

GERMANIC LANGUAGES AND LITERATURES

(Including German and Scandinavian)

The Department of Germanic Languages and Literatures offers work leading to the Master of Arts and Doctor of Philosophy. Students applying for admission must have a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Students should have completed a four-year course of undergraduate study in German corresponding to that of this University. They should be familiar with the principal works of the writers of the classical and modern periods of German literature, possess a general knowledge of the history of German letters and civilization, and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is highly desirable. A reading knowledge of French is required for advanced graduate work. A reading knowledge of one additional language, to be determined on the basis of the candidate's research needs, is required for admission to the third year of graduate study.

Fields of concentration for advanced degrees include German philology and linguistics, older literature, and modern literature.

Candidates for the Master of Arts in the Teaching of German must earn four units in German, two units in education, and two units in electives. Requirements are: German, two or two and one-half units to be chosen from German 301, 302, 311, 312, 320, 331, 332, 415, or 420; one and one-half to two units from German courses open only to graduates; education, two units, including two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The electives must be selected with the approval of the adviser.

GRADUATE FACULTY

Professors: J. R. Frey, P. M. Mitchell, E. A. Philippson, H. Stegemeier.
Associate Professors: H. G. Haile (Chairman of Department), F. J. Nock.
Assistant Professors: Ruth E. Lorbe, Pauline S. Schwalbe.

German

COURSES FOR GRADUATES

400. Beginning German for Graduate Students. Introduction to the reading of German texts in the sciences and the humanities. No graduate credit. Schwalbe.

401. Readings in German for Graduate Students. Designed for graduate students preparing for the German reading requirements for the Ph.D. No graduate credit. Prerequisite: German 400 or equivalent. Schwalbe.

411. Proseminar. Methods of literary criticism and research. 1 unit. Staff.

415. Middle High German. 1 unit. Nock.

416. Middle High German Literature. 1 unit. Prerequisite: German 415 or equivalent. Nock.

420. History of the German Language. 1 unit. Philippson.

426. Gothic. An introduction to Germanic (comparative) linguistics. 1 unit. Offered in 1967-1968 and in alternate years.

431. German Literature of the Middle Ages. German literature from 800 to 1400. 1 unit. Offered in 1967-1968 and in alternate years. Philippson.

432. German Literature from 1400 to 1700. Renaissance, Reformation, and Baroque in German literature. Lectures and readings. 1 unit. Offered in 1967-1968 and in alternate years. Philippson.

441. German Romanticism. 1 unit. Offered in 1967-1968 and in alternate years. Mitchell.

442. **Nineteenth-Century German Realism.** 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: German 301 and 302 or equivalent. FREY.

445. **Old High German.** Grammar and interpretation of the oldest literary documents. 1 unit. Offered in 1966-1967 and in alternate years. PHILIPPSON.

451. **Naturalism, Symbolism, Expressionism.** German literature from the 1880's to the 1920's. 1 unit. Offered in 1966-1967 and in alternate years. FREY.

452. **German Literature from the Twenties to the Present.** 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: German 301 and 302, or equivalent. FREY.

460. **Seminar in German Literature.** Advanced research work in German literature; discussion of problems and papers. 1 unit. STAFF.

493. **Research in Special Topics.** 1 to 4 units. STAFF.

495. **Bibliography and Methods of Literary History.** To be taken concurrently with German 411. ½ unit. FREY.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **German Literature to 1700.** ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

302. **German Literature Since 1700.** ¾ unit. Prerequisite: German 210 and one other course in German literature. FREY.

303. **Advanced Conversation, Composition, and Syntax.** Extensive study of advanced problems of grammar, syntax, and style, ½ unit. Prerequisite: Three years of college German including German 212, or consent of instructor.

304. **Advanced Conversation.** Practice in free conversation with native speaker. No graduate credit. Prerequisite: German 303 or equivalent.

305. **Modern German Poetry.** A political and metrical survey of modern German lyric verse. ¾ unit. Prerequisite: German 210 and one other literature course or its equivalent, or consent of instructor.

307. **The Structure of the German Language.** Study of the structure of the German language with emphasis on contrastive syntax of English and German. ¾ unit. Prerequisite: German 210 and 212.

311. **Goethe.** Introduction to Goethe's life and works. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: German 210 and one other course in German literature. MITCHELL.

312. **Goethe's Faust.** Intensive study of Goethe's *Faust*, Parts I and II. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

320. **History of German Civilization.** A selected topical, historical, and pictorial analysis of German culture and civilization. ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

331. **The Age of Lessing.** ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

332. **Schiller.** ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

360. **Introduction to German Phonetics.** ½ unit. Prerequisite: Consent of instructor. NOCK.

382. **Language Laboratory Techniques.** Same as French, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

Scandinavian

COURSES FOR GRADUATES

405. **Old Norse-Icelandic, I.** Grammar and selected readings. 1 unit. Offered in 1967-1968 and in alternate years. MITCHELL.

406. **Old Norse-Icelandic, II.** Readings. Selections from the Elder Edda and the sagas. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Scandinavian 405. MITCHELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. **Ibsen.** The dramas in English translation; selected works of Ibsen's Scandinavian contemporaries. 1 unit. Offered in 1967-1968 and in alternate years. MITCHELL.

362. **Strindberg and the Later Scandinavian Dramatists.** Major dramas and prose works of August Strindberg in translation; selected plays by Kaj Munk, Kjeld Abell, Nordahl Grieg, and Pär Lagerkvist. 1 unit. Offered in 1966-1967 and in alternate years. MITCHELL.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs renders advisory, consulting, and research services to the government of Illinois and their elected and appointed officials. Using the data acquired in these activities, the staff seeks, through scholarly and popular publication, to advance knowledge about the science of government and the political process.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of study leading to the Master of Science in Health Education. This program is centered in preparing teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for preparation in the special fields of public health education and safety education.

Admission Requirements for a major in this field are: (1) a grade-point average of 3.75 (although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in health education or closely related courses: (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Requirements for the master's degree are eight units to include: (1) four units in health education or approved courses in physical education; (2) two units in education: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; (3) satisfactory completion of Health Education 490, no credit: (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements but will be required to take two units' credit in lieu of thesis credit, and in addition, to pass a final comprehensive written examination in health education.

GRADUATE FACULTY

Professors: H. S. HOYMAN (Head of Department), W. H. CRESWELL, JR., A. E. FLORIO, W. J. HUFFMAN.

Lecturers: C. A. BRIDGER, ISABELLE M. CRAWFORD, E. L. WITTENBORN, JR.

Health Education

COURSES FOR GRADUATES

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and principles as these apply to the further improvement of personal, family, and community health. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. HOYMAN.

401. **Problems in School Health Education.** History, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. 1 unit. CRESWELL, HOYMAN, HUFFMAN.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. ½ or 1 unit. STONE.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. HOYMAN, HUFFMAN.

490. **Seminar.** Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. No credit. STAFF.

493. **Special Projects.** Independent research. Open only to candidates for the Doctor of Philosophy. ½ or 1 unit. Prerequisite: Educational Psychology 390. Physical Education 495, and Health Education 400, or equivalent. STAFF.

499. **Thesis Research.** Preparation of theses in health and safety education. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. HOYMAN, LEVINE, STAFF.

390. **Public Health Education.** Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers; projects in preparing and using public health education materials; evaluation of research in public health education. ½ unit Prerequisite: Consent of instructor. STONE.

391. **Public Health Statistics.** An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central

tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. ½ unit. Prerequisite: Mathematics 161 or Educational Psychology 390, or equivalent. BRIDGER.

Safety Education

COURSES FOR GRADUATES

402. **Problems in Safety Education.** Philosophy of safety: traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. 1 unit. FLORIO, HUFFMAN.

HISTORY

The Department of History offers work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work in history presupposes two years of undergraduate study in this subject, or a minimum of sixteen semester hours, including courses in European and American history. Undergraduate linguistic preparation, especially in French, German, or Russian, is important. For ancient and medieval history, some knowledge of Greek or Latin may be essential. Spanish is useful for certain fields of European, American, and Latin-American history.

Admission to graduate study in history requires a grade-point average of at least 4.0 for the last sixty hours of undergraduate study. Students with averages below 4.0 but above 3.75 are considered on an individual basis. A student who has done graduate work in a recognized institution but without receiving a degree may petition to receive credit toward an advanced degree by passing examinations in this work.

Master of Arts. During his first term, each candidate must pass a comprehensive qualifying examination in three of the following six areas: ancient, medieval, modern Europe after 1500, English, American, and Near and Far Eastern. Special provisions may be made for those who did not major in history in an American college or university. Candidates are expected to take at least two units in two of the fields of specialization for the Doctor of Philosophy listed below. A minimum of eight units is required for the Master of Arts and three of these units must be at the 400 level. The program must include two research seminars with grades of B or better. Students may elect to write a master's thesis, but the thesis does not replace the seminar requirement. Candidates must demonstrate a reading knowledge of one foreign language—French, German, or Russian—by passing an examination administered by the language department.

Graduate study in history may also be pursued in connection with the Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see page 313).

Doctor of Philosophy. The Department of History offers the following fields of specialization and preparation: ancient Greece; ancient Rome; medieval, to 1300; Europe, 1300-1648 (Renaissance and Reformation); Europe and dependencies, 1648-1815; Europe and dependencies since 1815; Russia; England to 1688; England and the Empire-Commonwealth since 1688; Near East and Middle East; China; Japan; South Asia; early America to 1789; United States since 1789; Latin America; History of Science.

Candidates who have not previously taken the department's comprehensive qualifying examination are required to do so during their first semester of doctoral study. A candidate must demonstrate ability to read two of the following languages: French, German, Russian. A student who has not passed the examination in one language will not be readmitted to a second year of graduate study. No student is rec-

ommended for financial aid of any kind for a third year of study who has not passed both language examinations.

Two research seminars are normally required for all candidates if these were not taken here in the master's program. History 496 and 498 also are required. The doctorate requires a minimum of sixteen units beyond the master's degree. Eight of these may be thesis research credit.

Candidates must offer five fields of preparation for their preliminary examination; four in history and one in a related subject. The major field in which the thesis is to be written requires a minimum of four units; the first minor field, a minimum of three units; and the others, two units each. Fields other than those listed above may be accepted in individual cases.

The second minor field may be selected from the following departments and areas: political science, economics, education, sociology, philosophy, and literature. Other suitable second minors may be arranged.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor, three units, in American literature, and a second minor, two units, in the history of fine arts in the United States.

Illinois Historical Survey. Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, students in history are able to obtain useful training in the study of manuscript as well as printed materials.

GRADUATE FACULTY

Professors: R. W. Johannsen (Chairman of Department), C. E. Dawn, E. L. Erickson, R. T. Fisher, Jr., D. Geanakoplos, N. A. Graebner, H. M. Hyman, C. E. Nowell, P. W. Schroeder, C. C. Spence, C. G. Starr, R. P. Stearns, R. M. Sutton.

Associate Professors: J. L. Bates, R. B. Crawford, J. A. Nichols, J. B. Sirich, W. U. Solberg, R. J. Vecoli.

Assistant Professors: B. D. Hill, H. H. Kaplan, B. B. Kling, R. F. Kuisel, R. M. McColley, R. E. Mitchell, R. A. Waller, G. M. Wilson.

Instructor: B. P. Uroff.

COURSES FOR GRADUATES

403. Problems in Early Modern European History to 1815. 1 unit. Staff.

404. Problems in Modern European History Since 1815. 1 unit. Staff.

407. Problems in American History to 1865. 1 unit. Staff.

408. Problems in American History Since 1865. 1 unit. Staff.

411. Seminar in Ancient History: Greece. 1 unit. Mitchell, Starr.

413. Seminar in Ancient History: Rome. 1 unit. Mitchell, Starr.

415. Seminar in Medieval History. 1 unit. Geanakoplos.

417. Seminar in Renaissance and Reformation History. 1 unit. Geanakoplos.

419. Seminar in European History, 1648-1815. 1 unit. Sirich.

421. Seminar in European History Since 1815. 1 unit. Friedlander, Kuisel, Nichols, Schroeder.

423. Seminar in English History to 1688. 1 unit. Hill.

425. Seminar in English and British Empire History Since 1688. 1 unit. Erickson.

427. Seminar in Russian History. 1 unit. Fisher, Kaplan, Uroff.

441. Seminar in Near and Middle Eastern History. 1 unit. Dawn.

443. Seminar in South Asian History. 1 unit. Kling.

445. Seminar in East Asian History. 1 unit. Crawford, Wilson.

451. **Seminar in Early American History to 1789.** 1 unit. STEARNS.

453. **Seminar in American History Since 1789.** 1 unit. BATES, GRAEBNER, HYMAN, JOHANNSEN, MCCOLLEY, SOLBERG, SPENCE, SUTTON, VECOLI, WALLER.

461. **Seminar in Latin-American History.** 1 unit. NOWELL.

471. **Seminar in the History of Science.** 1 unit.

496. **History of Historiography.** Introduction to the great historians from early times to the present. 1 unit. STARR.

497. **Reading Course.** Directed reading in special fields. Open only to students with a master's degree or equivalent, who are preparing for the preliminary examination in history and who need instruction in areas not provided by current course offerings. 1 unit. Prerequisite: Master's degree or equivalent; consent of instructor. STAFF.

498. **Problems in the Teaching of College History.** No credit. Prerequisite: Candidate for Ph.D. degree in history. STAFF.

499. **Thesis Research.** Individual direction in research and guidance in writing theses for advanced degrees. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The general prerequisite for all graduate students registering in 300-numbered courses is one year of college history or consent of instructor.

301. **The Middle Ages from 400 to 1100 A.D.** Europe from the fall of Rome to the first crusade. ½ or 1 unit. GEANAKOPLOS.

302. **The Middle Ages from 1100 to 1500 A.D.** Europe from the rise of towns to the establishment of national monarchy. ½ or 1 unit. GEANAKOPLOS.

303. **History of Byzantine Civilization.** A study of cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D. to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. ½ or 1 unit. GEANAKOPLOS.

304. **Medieval Civilization.** Religious and intellectual. ½ or 1 unit. Prerequisite: One year of college history or political science. GEANAKOPLOS.

305. **The Age of the Renaissance.** ½ or 1 unit. GEANAKOPLOS.

306. **The Age of the Protestant and Catholic Reformation, 1500-1648.** ½ or 1 unit.

307. **Classical Islam: The Near East from Mohammed to the Crusades.** ½ or 1 unit. DAWN.

308. **The Europeanization of the Near East, 1768-1914.** ½ or 1 unit. DAWN.

309. **Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789.** ½ or 1 unit. SIRICH.

310. **Development of Modern Europe: The French Revolution and Napoleon, 1789-1815.** ½ or 1 unit. SIRICH.

311. **European History from 1815 to 1871.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

312. **European History from 1871 to 1918.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

313. **European History from 1918 to 1939.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KUISEL.

314. **European History from 1939 to the Present.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KUISEL.

317. **Modern Italy, 1815 to the Present.** A survey of Italian political, social, economic, and cultural developments from the aftermath of the Napoleonic wars to the post-Second World War republic. ½ or 1 unit.

318. **Modern European Diplomatic History, 1789-1890.** The diplomatic history of Europe from the French Revolution to the fall of Bismarck. ½ or 1 unit. SCHROEDER.

319. **Modern European Diplomatic History, 1890 to the Present.** The diplomatic history of Europe from the fall of Bismarck to the present day. ½ or 1 unit. SCHROEDER.

320. **Russia from the Earliest Times to Peter the Great.** The political, economic, cultural, and social development of Russia during the Kievan and Muscovite periods. ½ or 1 unit. UROFF.

321. **Russia from Peter the Great to 1855.** The political, economic, cultural, diplomatic, and social development of Russia during Imperial times. ½ or 1 unit. KAPLAN.

323. **Intellectual History of Modern Europe, 1513-1770.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

324. **Intellectual History of Modern Europe, 1770 to the Present.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

325. **Intellectual and Cultural History of Russia to 1881.** ½ or 1 unit. UROFF.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. UROFF.

327. **The Russian Revolution.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

328. **History of Soviet Russia from 1917 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

329. **History of East Central Europe to 1815.** Survey of the political and cultural developments of the Western Slavs and their Baltic and Danubian neighbors, from the origin of the kingdoms of Poland, Bohemia, and Hungary to the Congress of Vienna. ½ or 1 unit. KAPLAN.

330. **History of East Central Europe from 1815 to the Present.** The development of nationalism in East Central Europe since the Congress of Vienna; the Revolutions of 1848; the growth of nationalism and the struggle for independence; the establishment of national states; the First World War and Versailles; the interwar period; the Second World War and the Communist take-over. ½ or 1 unit. KAPLAN.

332. **Medieval England.** Religious, social, intellectual, and economic developments in medieval England from the period of the Germanic invasions to the accession of the Tudors. ½ or 1 unit. HILL.

333. **Great Britain Under the Tudors and Stuarts, 1485-1660.** The principal political, economic, social, religious, and cultural developments in British history, including Scotland and Ireland, from the beginning of the Tudor dynasty to the Restoration of 1660. ½ or 1 unit.

334. **Great Britain Under the Later Stuarts and the Hanoverians, 1660-1815.** The principal political, economic, social, religious, and cultural developments in British history from the Restoration to the end of the Napoleonic wars. ½ or 1 unit.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and Economics 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics of American history. SCHWEITZER.

339. **History of the British Commonwealth in the Nineteenth Century, 1783-1900.** ½ or 1 unit. ERICKSON.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** ½ or 1 unit. ERICKSON.

341. **Modern Britain: The Victorian Era, 1815-1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. ERICKSON.

342. **Modern Britain Since 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. ERICKSON.

345. **Constitutional History of England to 1485.** ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

346. **Constitutional History of England, 1485 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

347. **The Emergence of Modern Science to the Age of Newton.** A history of science from ancient times to the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor.

348. **The History of Modern Science Since the Age of Newton.** The development of the sciences and scientific principles since the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor.

349. **The Scientific Revolution, 1543-1727.** A study of the birth of modern science in the seventeenth century, with special emphasis upon the rise of experimentalism, the growth of mathematical science, and the establishment of the mechanical philosophy. ½ or 1 unit.

352. **Colonial Beginnings of American Life and Institutions.** A study of the seventeenth- and eighteenth-century colonies. ½ or 1 unit. STEARNS.

354. **The Era of the American Revolution, 1763-1789.** ½ or 1 unit. STEARNS.

355. **Federalists, Jeffersonians, and the Era of Good Feelings.** United States history from 1789 to 1828 with emphasis on the conflict between nationalism and sectional interests. ½ or 1 unit. MCCOLLEY.

356. **History of the United States, Jackson to the Civil War.** Study of Jacksonian democracy; the rise of sectionalism; manifest destiny and the Mexican War; the issue of slavery and expansion and the approach of the Civil War. ½ or 1 unit. JOHANNSEN.

357. **Economic History of the United States, 1775-1860.** The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. ½ or 1 unit. SPENCE.

358. **Economic History of the United States Since 1860.** The growth of American economic life and institutions since 1860. ½ or 1 unit. SPENCE.

359. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. ½ or 1 unit. JOHANNSEN.

360. **History of the United States, 1877-1909.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

361. **History of the United States, 1909-1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

362. **History of the United States Since 1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. VECOLI.

363. **Social History of Industrial America to 1890.** The impact of industrialization, immigration, and urbanization on American society in the nineteenth century. ½ or 1 unit. VECOLI.

364. **Social History of Industrial America Since 1890.** A study of the impact of industrial technology, business enterprise, immigration, and urbanization on American society. ½ or 1 unit. VECOLI.

365. **The History of Illinois to 1870.** Evolution of a typical midwestern commonwealth, with emphasis upon its political, economic, social, religious, and cultural development in the nineteenth century. ½ unit. SUTTON.

366. **The History of Illinois from 1870 to the Present.** The evolution of a modern American state, with emphasis upon its political life, economic growth, social and intellectual problems, and its contribution to the American nation. ½ unit. SUTTON.

367. **The Trans-Mississippi West.** The history of Western expansion since the Louisiana Purchase; the West in the general history of the United States; Western economic and political problems. ½ or 1 unit. SPENCE.

368. **History of the South.** An inquiry into the question, when did the South begin and what have been its distinguishing traits? Special attention is given to agrarianism, industrialization, and the race problem. ½ or 1 unit. BATES.

369. **Constitutional Development of the United States to 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science. HYMAN.

370. **Constitutional Development of the United States Since 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science. HYMAN.

371. **American Intellectual and Cultural History to 1877.** Social and political thought, religion, science, scholarship, and education as both results and causes of American experience. ½ or 1 unit. SOLBERG.

372. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. ½ or 1 unit. SOLBERG.

373. **Diplomatic History of the United States to the End of the Nineteenth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science. GRAEBNER.

374. **Diplomatic History of the United States in the Twentieth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science. GRAEBNER.

375. **History of Latin America to 1824.** A survey of Latin-American history from the discovery of America until 1824. ½ or 1 unit. NOWELL.

376. **Latin America Since 1824.** A history of the Latin-American republics from their independence to the present. ½ or 1 unit. NOWELL.

377. **History of the A.B.C. Powers.** History of Argentina, Brazil, and Chile from their origins to the present. ½ or 1 unit. Prerequisite: One year of college history or enrollment in Latin-American studies program. NOWELL.

381. **Ancient Greek States.** History of the Greek states from the earliest times to 334. B.C. ½ or 1 unit. STARR.

382. **Alexander and His Successors.** ½ or 1 unit. STARR.

383. **History of the Roman Republic to 44 B. C.** ½ or 1 unit. MITCHELL.

384. **The Roman Empire.** ½ or 1 unit. MITCHELL.

387. **Indian History and Civilization to 1707.** Development of Indian civilization up to the British conquest. Political evolution; religious and philosophical systems; society, art, and literature during Hindu and Muslim periods. ½ or 1 unit. KLING.

388. **Development of Modern India and Pakistan from 1707.** Establishment and organization of the British Empire in India; reaction of India to the Western impact; growth of nationalism and the struggle for independence. ½ or 1 unit. KLING.

389. **Problems of Contemporary South Asia.** Current political, economic, social, and cultural problems of India, Pakistan, and Ceylon dealt with in the perspective of the historical development of South Asia. ½ or 1 unit. KLING.

391. **A History of China to 906 A.D.** A history of the formative period of the Chinese state, society, and economy. ½ or 1 unit. CRAWFORD.

392. **A History of China, 907-1840.** A history of the early modern Chinese state and society prior to the Western impact. ½ or 1 unit. CRAWFORD.

393. **Chinese Intellectual History from Earliest Times to the Present.** A study of the major ideas and schools of thought as they have affected the course of Chinese history and the development of its institutions. ½ or 1 unit. CRAWFORD.

394. **Modern China, China Since 1840.** A study of China's response to the Western impact, with special emphasis on the Nationalist revolution, and the rise of the Communist party of China and its domestic and foreign policies. ½ or 1 unit. CRAWFORD.

395. **Premodern Japan.** Japanese history from its origins to 1800; evolution of the traditional society, stressing institutional and cultural problems of the ancient, "feudal," and early modern (Tokugawa) period. ½ or 1 unit. WILSON.

396. **Modern Japan.** Japanese history since 1800; institutional and cultural problems connected with Western pressure, the Meiji Restoration, rise and fall of empire, and creation of a modern society. ½ or 1 unit. WILSON.

398. **Intellectual History of Japan.** Shinto, Buddhism, Confucianism, and Western thought as cultural and social forces in the evolution of Japan from its origins to the present. ½ or 1 unit. Prerequisite: One year of college history or philosophy. WILSON.

HOME ECONOMICS

The Department of Home Economics offers work leading to the Master of Science or Master of Arts in Home Economics; Master of Science in Home Economics Education; and Doctor of Philosophy in Home Economics with a major in foods and nutrition. The major work for a master's degree in home economics may be done in one of six curricula as shown below. The minimum grade-point average for admission to graduate study in home economics and home economics education is 3.75. Applications of students with averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science or Master of Arts. Candidates for a master's degree in home economics must complete a minimum of eight units (nine if a thesis is not submitted), of which at least four must be in home economics. Four of the total units, including at least two in home economics, must be in 400-level courses.

Lists of suggested electives for each curriculum are available from the department upon request. Required courses for each of the six curricula are given below:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 305, 410, 418, 419, and 499.

(2) *Family and Consumption Economics.* A minimum of four units from Home Economics 370, 379, 470, 499, with credit in Home Economics 370 and 499 required. A minimum of two units from Economics 300, 301, 400-401, or 402-403.

(3) *Family Housing and Household Management.* A minimum of nine units; two from Home Economics 361, 370, 375, 378, 379 and 470; Agricultural Engineering 300, and Architecture 339; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from Urban Planning 372, Economics 313, Finance 369, Sociology 407, 476, 477.

(4) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499; also, Chemistry 354 or 350 and 355 are required.

(5) *General Home Economics.* A minimum of four units from prescribed courses in three of the other five curricula in home economics.

(6) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 395, 480, 487, and 499.

Candidates for the Master of Science in Home Economics Education must earn eight units, four of them in home economics. Three of the eight units must be in 400-numbered courses and at least one of these must be in home economics. Courses in home economics are to be chosen from Home Economics 301, 320, 322, 323, 326, 330, 331, 361, 375, 378, 379, 380, 386, 388, 395, 410, 418, 419, 480, and 487; Educational Psychology 311 and 312, one unit; two of the following courses: History and Philosophy of Education 301 302, 303, 304, one unit; Vocational and Technical Education 453, one unit; Vocational and Technical Education 456, one unit, or Home Economics 377, one-half to one unit.

Doctor of Philosophy. Candidates for this degree with a major in foods and nutrition must present an undergraduate foods course with an organic chemistry prerequisite; a nutrition course with organic chemistry and physiology prerequisites; adequate training in chemistry, including quantitative analysis and organic; and introductory courses in microbiology, physics, and trigonometry. A student emphasizing foods in the doctoral program should have had a course in colloid chemistry. Deficiencies in these requirements may be made up during the first year of graduate study.

Required courses include at least three units of foods and nutrition, two at the 400 level; one unit of statistical methods at the 400 level; courses in biochemistry and physical chemistry; and an advanced course in food microbiology or mammalian physiology. Additional courses in the above areas or in animal nutrition or food science are selected to satisfy major unit requirements. Candidates may minor in animal nutrition, biochemistry, food science, microbiology, physiology, and other appropriate areas. Either foods or nutrition is emphasized in research for the thesis.

Graduate students who choose an area of home economics as a minor for the Doctor of Philosophy must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in 400-level courses.

GRADUATE FACULTY

Professors: Janice M. Smith (Head of Department), Ruth L. Galbraith, Pearl Janssen, Frances Van Duyne.

Associate Professors: Mildred Bonnell, Marilyn M. Dunsing, Margaret Goodyear, Beulah Hunzicker, Glenna H. Lamkin, Queenie B. Mills, Willie Mae Mowrer, Lorraine D. Trebilcock.

Assistant Professors: Karlyne Anspach, Esther L. Brown, Beula V. McKey.

COURSES FOR GRADUATES

410. **Problems in Family Living.** Family relationships and their significance to the growth of family members. 1 unit. Prerequisite: Home Economics 210. Mowrer.

418. **Seminar in Child Development.** Advanced problems in child development. 1 unit. Prerequisite: Home Economics 301. Mowrer.

419. **Seminar in Family Relationships.** Critical evaluation of research literature in the field of marriage and family relationships. 1 unit. Prerequisite: Home Economics 410. Mowrer.

422. **Seminar in Nutrition.** A study of recent literature in nutrition. ½ or 1 unit. Prerequisite: Undergraduate degree in home economics, with emphasis on foods and nutrition, or comparable background in biochemistry, microbiology, physiology, or other biological science.

423. **Problems in Human Nutrition.** Methods of assessing nutritional status of humans. ½ or 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Home Economics 324 or equivalent.

430. **Carbohydrates in Foods.** Same as Food Science 430. A study of the physical and chemical properties of carbohydrates used in food and their behavior under con-

ditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 354 or 350 and 355, or consent of instructor.

432. **Seminar in Foods.** Review of current literature in foods research. ½ or 1 unit. Prerequisite: Undergraduate major in foods and nutrition, chemistry, microbiology, or physiology; consent of instructor. VAN DUYNE.

470. **Seminar in Family and Consumption Economics.** Same as Agricultural Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

480. **Seminar in Textiles.** Current literature related to development in the production, use, and care of textile fabrics. ½ or 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. GALBRAITH.

487. **Seminar in Clothing.** Study and discussion of research in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. ½ or 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. ANSPACH.

493. **Advanced Studies in Home Economics.** Library or experimental research on specific problems of limited scope. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. This is one of the courses which may be taken in addition to eight units required for a master's degree by students who do not write a thesis. ½ or 1 unit. STAFF.

499. **Thesis Research.** Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. 0 to 4 units. DUNSING, GALBRAITH, MILLS, MOWRER, SMITH, VAN DUYNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. ½ or 1 unit. Prerequisite: Home Economics 202 and 203; consent of instructor. MOWRER.

305. **Human Heredity.** Heredity in man and its relation to various individual and social problems. Lectures, discussions, and demonstrations. Graduate credit does not count toward a major in genetics. ½ unit.

313. **Economics of Consumption.** Same as Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

320. **Diet in Disease.** ½ unit. Prerequisite: Home Economics 220.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. ½ unit. Prerequisite: Home Economics 220; consent of instructor.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition. Readings, lectures, and discussions. S; ½ unit. Prerequisite: Chemistry 132 or 133; Physiology 103; Home Economics 220 and 231. MCKEY, VAN DUYNE.

324. **Problems in Nutrition.** Discussions and investigations. ½ or 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing. MCKEY.

326. **Presentations: Principles and Techniques.** Selection of problems and organization of materials for demonstrations and other presentations in home economics subject matter areas. Field trip; estimated cost, $15.00. ½ unit. Prerequisite: Senior standing; consent of instructor. LAMKIN.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. ½ or 1 unit. Prerequisite: Home Economics 231; Microbiology 100 and 101. JANSSEN.

331. **Problems in Foods.** Individual problems in food preparation and preservation. ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. **Institution and Restaurant Management: Food Purchasing and Equipment Selection.** Purchasing food and selecting equipment for quantity food service; factors affecting the purchase of food, relationship of floor plans and equipment to service. ½ unit. Credit is not given for both Home Economics 345 and 351. Prerequisite: Credit or registration in Home Economics 240; Economics 108. BONNELL.

350. **Institution and Restaurant Management: Organization and Administration.** The organization and administration of food service operations; management problems in various types of food service, personnel, costs, sanitary control. Field trips; estimated expense, $50.00. ½ or 1 unit. Credit is not given for both Home Economics 350 and 351. Prerequisite: Home Economics 220 and 240. HUNZICKER.

351. **Special Problems in Group Feeding.** For individuals interested in refreshing and strengthening knowledge in group feeding. Lectures, discussions, laboratory practice in quantity food management. Food handler's certificate required. No credit for students who have completed Home Economics 240, 345, or 350. S; ½ unit. Prerequisite: Home Economics 220 and 231, or equivalent; consent of instructor. BONNELL.

355. **Specialized Quantity Food Production and Management.** Advanced application of food production and management principles to special food service demands. Emphasis on artistry in preparation, serving, and merchandising high quality food in quantity. ½ unit. Prerequisite: Home Economics 240, credit or registration in Home Economics 350, or consent of instructor. BONNELL.

361. **Development and Function of Family Housing.** Same as Agricultural Engineering 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ¾ unit. Prerequisite: Home Economics 160 and 171, or consent of department. HANSEN.

370. **Family Economics.** Same as Agricultural Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. ½ unit. Prerequisite: Home Economics 171; six advanced hours in home economics, including one of the following: Home Economics 231, 273, 380; consent of instructor.

377. **Cooperative Extension: Home Economics.** The philosophy, history, and organization of the cooperative extension service. Consideration of program development, methods of presentation, and evaluation with emphasis on socio-economic characteristics of state and county. ½ to 1 unit. Prerequisite: Economics 108; Psychology 100 and Sociology 100, or Educational Psychology 211, or Agriculture 206; consent of instructor.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the fields of family housing, home furnishings, and home management. ½ to 1 unit. Prerequisite: Home Economics 262 or 270; consent of instructor. GOODYEAR.

379. **Problems in Family and Consumption Economics.** Individual investigation of specific problems in the field of family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

380. **Advanced Textiles.** The effect of the physical and chemical structures of textile fibers on their properties, manufacturing processes, use, and care. 1 unit. Prerequisite: Home Economics 183; Chemistry 132. GALBRAITH.

386. **Clothing Design: Draping.** Designing by draping, inspired by appropriate design sources; understanding of fitting principles through fabric manipulations; design effects maintained in garment construction. 1 unit. Prerequisite: Home Economics 285 or consent of instructor; Home Economics 286. ANSPACH.

388. **Problems in Textiles and Clothing.** Investigation and report of individual problems in the field of textiles and clothing. ½ or 1 unit. Prerequisite: Home Economics 286 or 380 or Marketing 211; consent of instructor. ANSPACH, GALBRAITH, TREBILCOCK.

395. **Fashion Analysis.** A study of fashion terminology, selected designers, garment manufacturing techniques, and methods of fashion promotion used in retail outlets. Field trip; estimated expense, $10.00. ½ unit. Prerequisite: Advertising 281; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy. Candidates may specialize for either degree in floriculture, plant breeding, pomology, or vegetable crops.

The required grade-point average for admission to graduate study in horticulture is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Twenty hours of undergraduate work in horticulture and allied subjects are required of students who choose horticulture as a major, and twelve hours are required of those who select it as a minor. The department waives certain of these requirements for some fields of major study if the student has had an equivalent preparation in the fundamental sciences. It is desirable, when the major field of study is decided upon during the junior or senior year, to select the fundamental science courses accordingly and, if possible, to include in the undergraduate preparation the elementary courses in German or French.

Advanced work in agricultural economics, agronomy, botany, chemistry, entomology, genetics, or plant pathology may be taken advantageously with horticulture to make a well-balanced course of graduate study.

GRADUATE FACULTY

Professors: C. J. BIRKELAND (Head of Department) . C. Y. ARNOLD, J. R. CULBERT, J. B. GARTNER, M. B. LINN, R. V. LOTT, J. P. MCCOLLUM, D. POWELL, R. K. SIMONS, A. E. THOMPSON, J. S. VANDEMARK.

Associate Professors: H. C. BARRETT, D. F. DAYTON, E. R. JAYCOX, A. M. RHODES, J. S. TITUS.

Assistant Professors: L. BEEVERS, D. B. DICKINSON, T. K. HODGES, C. C. ZYCH.

COURSES FOR GRADUATES

424. **Mineral Nutrition of Plants.** Same as Agronomy and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The

scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Veterinary Medical Science 441. A continuation of Horticulture 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Horticulture 440 or equivalent.

447. **Horticulture Seminar.** Discussion of current research and literature pertaining to problems of horticulture and related fields. 1/4 unit. STAFF.

490. **Research Methods in Horticulture.** Lectures, discussions, demonstrations, and laboratory exercises dealing with methods and apparatus used in horticultural research. 1 unit. Prerequisite: Chemistry 133 or equivalent; Chemistry 122 or equivalent; Botany 330; five hours of physics. STAFF.

492. **Special Topics in Horticulture.** Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. 1/2 to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. STAFF.

499. **Thesis Research.** Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **Floricultural Physiology.** A study of the physiology and metabolism of floricultural crops during their development from seeds through flowering. Lectures and discussion. 1 unit. Prerequisite: Botany 230 and 231, or equivalent; one semester of organic chemistry. BEEVERS.

322. **Plant Nutrition.** A study of the mechanisms of and factors affecting the absorption, transport, and functions of the essential elements required by higher plants. Lectures, discussions, and laboratory. 1 unit. Prerequisite: Botany 230 and 231, or equivalent; one semester of organic chemistry. HODGES.

323. **Principles of Plant Breeding.** Same as Agronomy 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, the maintenance of high quality seed stocks. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. HADLEY, HITTLE, THOMPSON.

335. **Economics of Food Distribution.** Same as Agricultural Economics 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. 3/4 or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or Marketing 101. KELLY.

345. **Growth and Development of Horticultural Crops.** Factors affecting growth, development, and quality of vegetable crops. Lecture and discussion. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Botany 230 or equivalent, or consent of instructor. MCCOLLUM.

361. **Individual and Group Behavior of Honey Bees.** Same as Entomology 361. Study of individual and group behavior of honey bees, their biological value, physical basis, and evolution. Lectures and discussions, one or more local field trips, term paper, and assigned reading. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

HUMANITIES

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Comparative Literature, I.** A comparative study of great books in Greek, Roman, Italian, and Spanish literature. ½ unit.

364. **Introduction to Comparative Literature, II.** A comparative study of great books in French, German, and Russian literature. ½ unit.

INDUSTRIAL ADMINISTRATION

The Department of Industrial Administration offers graduate work either as a major or a minor leading to the Master of Science in management, and as a minor for the Doctor of Philosophy.

Admission requires a grade-point average of 3.75 for the last sixty hours of undergraduate study. Candidates with a grade-point average between 3.5 and 3.75 may be considered on an individual basis. Such students may be required to take an appropriate examination such as the Admission Test for Graduate Study in Business (fee $10.00) .

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration and related subjects. To do minor work in this field, at least twelve hours of work in business administration and related subjects are required.

GRADUATE FACULTY

Professors: C. F. DUNHAM (Acting Head of Department), P. M. DAUTEN, JR., P. M. GREEN, E. G. PLANTY, P. C. ROBERTS.

Associate Professors: R. L. BLACK, R. N. CORLEY, B. F. KIRKPATRICK.

Assistant Professors: H. HINOMOTO, H. J. ZIMMERMANN.

COURSES FOR GRADUATES

401. **Scientific Management—Qualitative.** A study of modern management principles, function, processes, and activities, with major emphasis upon developing a scientific body of administrative knowledge. 1 unit.

402. **Scientific Management—Quantitative.** A study and analysis of the quantitative techniques and controls available to modern management, with major emphasis upon integrating qualitative and quantitative management concepts. 1 unit.

416. **Problems in Business Policy.** Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. 1 unit. Prerequisite: Consent of instructor.

448. **Problems of Personnel Management.** Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel

function in management. This course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 248 or equivalent, or consent of instructor.

449. **Problems of Personnel Management.** Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Industrial Administration 248, 448, or equivalent.

491. **Seminar in Special Topics.** For lectures in topics of current interest not covered by regular course offerings. Subjects will be announced in the Time Table. ¼ to 1 unit. Prerequisite: Consent of instructor or department head.

499. **Thesis Research.** 1 unit. DUNHAM.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Business Torts.** Liability of businessmen for their wrongful acts and those of their agents arising separate and apart from their liabilities under contracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, including breach of contract. ¾ or 1 unit. Prerequisite: Industrial Administration 200; senior standing. KIRKPATRICK.

301. **The Law of Security Transactions and Banking.** Significant phases of law in the fields of pledges, chattel mortgages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. ¾ or 1 unit. Prerequisite: Industrial Administration 200; senior standing.

302. **Wills, Estates, and Trusts.** A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. ¾ or 1 unit. Prerequisite: Industrial Administration 200; senior standing.

311. **Administrative Policies and Organization.** Development of administrative organization and the determination of policies for the integration of major activities of a business enterprise. ½ or ¾ unit. Prerequisite: Industrial Administration 210; Marketing 201.

312. **Human Relations in Business.** Same as Labor and Industrial Relations 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and different economic and social groups. ½ or ¾ unit. Prerequisite: Industrial Administration 101 or equivalent.

315. **Management in Manufacturing.** Internal problems of production and efficient control in factories. ½ unit. Prerequisite: Industrial Administration 101.

320. **Organization Theory and Practice.** A study of the means used to achieve coordinated effort toward the accomplishment of objectives. Includes a consideration of both "classical" concepts for the division and integration of work through formal organizational structures along with behavioral science concepts of the forces that draw people into groups and the factors which aid or hinder their collective effectiveness. The principal objective is to give the student knowledge of the processes of analyzing and planning organizations to accomplish business objectives. ½ or ¾ unit. Prerequisite: Industrial Administration 312.

JOURNALISM

The Department of Journalism offers graduate work leading to the Master of Science in Journalism. For the program leading to the Doctor of Philosophy in Communications, see page 112.

Admission to graduate work in journalism requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in journalism or a related field such as English or the social sciences; and (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Requirements for the master's degree include:

(1) A major of four units, or three units and one additional unit approved by the department. Candidates without acceptable undergraduate majors may be required to complete (a) one unit of Journalism 321, (b) one unit of advanced undergraduate courses in writing or editing, and (c) in individual cases, some combination of Journalism 204, 211, 223, and 291, without graduate credit.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A thesis of one unit (Journalism 499) or the preparation of a topic of general public interest for publication or broadcast (Journalism 490).

(4) A minimum of three units in courses at the 400 level, at least two of which must be in the major field.

(5) A comprehensive written examination in the student's major and minor fields and on the current master's reading list.

(6) A minimum total of eight units.

GRADUATE FACULTY

Professors: J. W. Jensen (Head of Department), T. Peterson.

Associate Professors: G. G. Hanson, H. S. Maclay, J. H. Schacht.

Assistant Professor: J. W. Carey.

COURSES FOR GRADUATES

468. **The Political Economy of Communications.** Same as Communications 468. Analysis of the structure, policy, and behavior of such media of communication as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. Guback.

470. **Communications and Popular Culture.** Same as Communications 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit.

471. **Proseminar in Communications, I.** Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control, and support; content, audience, and effect of the mass media. 1 unit. Carey, Staff.

472. **Proseminar in Communications, II.** Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. Maclay, Staff.

473. **History and Theory of Freedom of the Press.** Same as Communications 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. Carey, Jensen.

474. **Communications Systems.** Same as Communications 474. Analysis of the structure and development of communications systems; examination of the role of

communication in social change, political movements, and formal organizations. 1 unit. CAREY.

490. **Special Topics in Journalism.** ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

492. **Research Methods in Communications.** Same as Communications 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. WIGGINS.

499. **Thesis Research.** 1 to 2 units. Prerequisite: Graduate standing in journalism. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **High School Journalism.** Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. ½ unit. Prerequisite: History and Philosophy of Education 201 or consent of instructor. GILMORE.

311. **Law and the Press.** The historical background of the nature and meaning of the law as it relates to journalism and contemporary problems of freedom of expression. ½ unit.

321. **News Editing.** Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and make-up and design of newspaper pages. 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212 or consent of instructor. GILMORE, PUFFENBARGER, SCHACHT.

323. **Advanced Reporting.** Advanced types of news investigation and treatment. ½ unit. Prerequisite: Journalism 211 and 212, or equivalent. PUFFENBARGER.

326. **Magazine Article Writing.** Preparation of feature stories and articles; techniques of marketing, market analysis, and publishing articles written in the course. ½ unit. Prerequisite: Journalism 211 or consent of instructor. GRAHAM, SCHACHT.

327. **Special Topics in Twentieth-Century Journalism.** Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. ½ unit. Prerequisite: Journalism 211 or consent of instructor.

329. **The Rhetoric of Journalism.** Studies in journalistic method, involving principally the analysis of structure and writing style as related to purpose. Materials are drawn from English and American journalism from the seventeenth century to the present, but emphasis is on work published in twentieth-century American newspapers and periodicals. ½ unit. Prerequisite: Journalism 211 or consent of instructor. SCHACHT.

330. **Magazine Editing.** Basic principles of editing for consumer, business, trade, and company magazines; communications theory, market analysis, editorial process, design process, production process, and distribution process as they relate to magazine publishing. ½ unit. Prerequisite: Credit or registration in Journalism 326. SCHACHT.

341. **Newspaper Management.** Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circulation, and commercial printing departments; plant operation. ½ unit. Prerequisite: Credit or registration in Journalism 204.

344. **Community Newspaper Publication.** Study of weekly and small- and medium-sized daily newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. ½ unit. Prerequisite: Journalism 212 or consent of instructor. GILMORE.

372. **Social Aspects of Mass Communications.** Same as Communications and Sociology 372. Media structures related to cultural content and functions. Problems of life and society as treated in mass-produced communications. ½ unit. GUBACK.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a Master of Arts degree in Labor and Industrial Relations. Students taking master's or doctoral degrees in other departments—economics, industrial administration, communications, history, political science, sociology, psychology, and others—may arrange a minor in labor and industrial relations.

Graduate instruction is offered in trade union and management organization, in the accommodation of these organizations through the process and structure of collective bargaining, in personnel administration and employee relations, in the role of government in legislating labor standards and labor relations, and in the formulation of public policy. These matters are studied in the context of social, economic, and political change, and are analyzed with the help of theoretical and empirical formulations of economics, history, law, political science, psychology, and sociology.

A student seeking admission to the Institute must meet the general entrance requirements of the Graduate College. In addition, the Institute reviews the undergraduate record of every candidate and may refuse admission to a student whose record indicates inadequate preparation. Prerequisites are a course in labor problems and a course in statistics. Students who can not meet these course prerequisites may register for graduate work but must remove the deficiency during the first semester by taking the required course or courses without graduate credit. Course work in the various social sciences is desirable as preparation for the Institute program.

A candidate for a Master of Arts in Labor and Industrial Relations has a choice of study programs. Program A requires eight units of graduate credit including one unit of research seminar (Labor and Industrial Relations 493), a minimum of two units of thesis (Labor and Industrial Relations 499), five units of electives, and successful completion of an oral examination focused on the thesis.

Program B requires a total of ten units including one unit of research seminar (Labor and Industrial Relations 493), one unit of readings (Labor and Industrial Relations 492), three units in three different academic disciplines (selected from economics, history, political science, psychology, or sociology), five units of electives, and successful completion of both oral and written comprehensive examinations focused on the course work. During his last semester at the Institute, a Program B student participates in a tutorial program during which he meets periodically with his tutor (a member of the faculty) and completes assigned essays or case studies on topics which will permit the use of concepts and methods of analysis of several disciplines.

Full details and further elaboration of the Institute programs and requirements are given in the bulletin, *Graduate Study for a Master of Arts Degree in Labor and Industrial Relations*, which may be obtained by writing to the Institute of Labor and Industrial Relations.

GRADUATE FACULTY

Professors: M. Wagner (Director of Institute of Labor and Industrial Relations), W. E. Chalmers, M. Derber, P. L. Garman, J. R. Gusfield, B. Karsh, S. B. Levine, W. McPherson, A. F. Sturmthal.

Associate Professors: W. H. Franke, M. Rothbaum, H. C. Triandis.

Assistant Professors: C. L. Hulin, H. E. Trier.

COURSES FOR GRADUATES

418. **Seminar in Industrial and Economic Sociology.** Same as Sociology 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Labor and Industrial Relations 318 or consent of instructor. Karsh, Phillips.

420. **Formation of Public Policy.** Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. 1 unit. HAGAN.

435. **Motivation and Morale in Industry.** Same as Psychology 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. TRIANDIS.

440. **Labor Economics.** Same as Economics 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

441. **Labor Economics.** Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

442. **Collective Bargaining.** Same as Economics 442. The development of a theory of the continuing interactions between union and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. 1 unit. Prerequisite: Consent of instructor.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling; analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

444. **Economics of Manpower Resources.** Same as Economics 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. PARRISH.

446. **Foreign and International Labor Movements.** History and organization, economic and political policies of the major labor movements in the world; their international organizations; comparative analysis of particular problems confronting these movements; labor movements in underdeveloped areas; labor and economic development; labor under totalitarian regimes. 1 unit. Prerequisite: Consent of instructor. STURMTHAL.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. GARMAN.

448. **Problems of Personnel Management.** Same as Industrial Administration 448. An examination of the organization and administration of the personnel function in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 248 or equivalent, or consent of instructor.

449. **Problems of Personnel Management.** Same as Industrial Administration 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Labor and Industrial Relations 448 or equivalent.

450. **Management and Industrial Relations.** An analysis of the industrial relations function in management. Using case problems, research reports, and theoretical analyses, an examination is made of the development of the industrial relations function, alternate organizational approaches in dealing with employees and unions, the formation of labor relations policies, and management responsibilities in industrial relations. 1 unit. Prerequisite: Consent of instructor.

490. **Individual Topics.** A student in labor and industrial relations may register for this unit with the consent of his curriculum adviser and the adviser under whom he will perform the individual study or research. Such individual work may include special study in a subject matter for which no course is available or an individual research project, including on-the-job research in industry, which is not being undertaken for a thesis. 0 to 2 units. STAFF.

492. **Readings in Labor and Industrial Relations.** Readings and analysis of important works in the field of industrial relations. The course is designed to emphasize the differing but complementary approaches of several social sciences to industrial relations problems. The interdisciplinary approach is sought both through selection of readings and through the participation of various Institute staff members in discussions dealing with their special interests. 1 unit. Prerequisite: Consent of instructor.

493. **Research Seminar in Labor and Industrial Relations.** Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, FRANKE.

494. **The Major Theorists of Industrial Relations.** An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. 1 unit. Prerequisite: Consent of instructor. DERBER.

496. **The Evolution of Labor-Management Relations in America.** Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. 1 unit. Prerequisite: Graduate standing in labor and industrial relations or consent of instructor. DERBER.

498. **Analysis of Organizations in Industrial Relations.** An intensive analysis of organizational behavior, with the main focus upon the theory of organizations as social institutions. Concepts are drawn from the various social sciences and applied to the principal organizations concerned with industrial relations. The internal dynamics

of unions, managements, and government agencies are examined, with special reference to decision-making processes, and are related to the interactions among them. 1 unit. Prerequisite: Consent of instructor. LEVINE.

499. **Thesis Research.** For all students writing theses in labor and industrial relations. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

312. **Human Relations in Business.** Same as Industrial Administration 312. Problems of the individual and groups brought about by modern industrial organizations and techniques; motivations for work and cooperation between executives and between different economic and social groups. ½ or ¾ unit. Prerequisite: Industrial Administration 101 or equivalent. DAUTEN.

318. **Industry and Society.** Same as Sociology 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH, PHILLIPS.

342. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108. MCNATT.

344. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240. MCNATT.

347. **Labor Law.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts. 1 unit.

355. **Industrial Social Psychology.** Same as Psychology 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid to understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or Labor and Industrial Relations 357. TRIANDIS.

357. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN.

360. **Group Insurance and Pensions.** Same as Finance 360. A study of the problems faced by management and labor in establishing employee benefit plans for death, disability, and retirement. Actual case problems are used in the course. ½ or 1 unit. Prerequisite: Economics 240, Finance 260, or Industrial Administration 248. MEHR.

365. **Government and Labor.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

LANDSCAPE ARCHITECTURE

The Department of Landscape Architecture offers work leading to the Master of Landscape Architecture degree. Students applying for admission must have a grade-point average of at least 3.75.

The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture or related fields of study. Those students whose undergraduate major is not substantially equivalent to the degree in landscape architecture conferred by the University of Illinois must expect to complete prerequisite courses before taking advanced work in landscape architecture.

To qualify for this degree, a student must complete (1) at least six units of graduate credit in required courses in landscape architecture, (2) at least two additional units to be chosen from the following fields: architecture, art, botany, civil engineering, forestry, geography, geology, horticulture, recreation, or urban planning. Required credit for the thesis is specified by the department.

GRADUATE FACULTY

Professors: W. G. Carnes (Chairman of Department), W. M. Keith.

Associate Professor: T. C. Hazlett.

Assistant Professors: A. J. Rutledge, D. L. Walker, Jr.

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semipublic, and public properties. 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

447. **Advanced Landscape Construction.** Advanced investigations and applications of new techniques of construction to landscape development. ½ or 1 unit. Prerequisite: Landscape Architecture 243, 244, bachelor's degree in landscape architecture, or consent of instructor. Hazlett.

457. **Advanced Planting Design.** Theory and application of planting design in relation to private, semipublic, and public properties. ½ or 1 unit. Prerequisite: Bachelor's degree in landscape architecture.

477. **Theory and Application of Landscape Design.** Advanced studies in the physical and ecological bases of landscape, aesthetic principles, and landscape planning. ½ or 1 unit. Prerequisite: Landscape Architecture 337 or consent of instructor.

487. **Seminar.** ½ or 1 unit.

499. **Thesis Research.** ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Advanced Landscape Design, I.** Advanced problems of landscape design for urban and institutional situations. 1 to 1½ units. Prerequisite: Landscape Architecture 236.

338. **Advanced Landscape Design, II.** Terminal project; comprehensive landscape architectural development. 1 to 2 units. Prerequisite: Landscape Architecture 337.

LATIN-AMERICAN STUDIES

Graduate minors in Latin-American studies are administered by the Center for Latin-American Studies Committee.

Candidates for the master's degree who elect a minor in Latin-American studies must complete two units from the courses listed below. Doctoral candidates who elect a minor in this area must complete four units for a sole minor, or two units for a split minor, from the following courses.

These elective courses must be taken in at least two departments and are described under the departmental listings: Agricultural Economics 401; Agronomy 429; Anthropology 350, 352, 361, 380, 490; Art 318, 491; Botany 300; Economics 352, 411, 490; Geography 332, 495; History 375, 376, 377, 476; Philosophy 319, 483; Political Science 342, 343, 441, 442, 493; Portuguese 301, 303, 304, 305, 306, 405, 406, 491; Sociology 373, 490; Spanish 307, 308, 332, 431, 432, 433, 434, 435, 436, 437, 438.

Students in technical and professional colleges and schools of the University who seek knowledge of Latin-American affairs, culture, and languages are invited to consult with the director of the Center for Latin-American Studies, 1207 West Oregon Street, Urbana, or with their advisers, in order to develop programs suited to their individual needs. Such a program may often be adopted as a special minor under existing regulations if the student so desires. These courses are of particular value to students who intend to carry on technical or professional work in the Latin-American area for the government, private business, publications, or religious organizations.

LAW

The College of Law offers a program of graduate work leading to the Master of Laws (LL.M.), Master of Comparative Law (M.C.L.), and Doctor of the Science of Law (J.S.D.).

A student whose undergraduate study in law has been in systems based on the Anglo-American common law is eligible to apply for candidacy for the Master of Laws or Doctor of the Science of Law. A foreign lawyer whose prior law study has been in a system which is not based on the Anglo-American common law may, in exceptional cases, be admitted to candidacy for the Master of Laws or Doctor of the Science of Law, or such foreign lawyer may apply for candidacy for the Master of Comparative Law. The Master of Comparative Law program is designed to develop facility in the comparative method and to prepare a foreign lawyer to deal knowledgeably with Anglo-American problems.

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws unless he has a grade-point average of 3.5 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of Science of Law is normally required to have a grade-point average of 4.0 in all law work previously undertaken, and also to present evidence that he has the ability to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Doctor of Law (or equivalent degree), or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for an advanced degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the Master of Laws must secure an average of 3.5 in his graduate law courses; the candidate for the Doctor of the Science of Law, an average of 4.0.

Details of the programs may be obtained from the Dean of the College of Law, 209 Law Building.

GRADUATE FACULTY

Professors: R. N. Sullivan (Dean of College of Law), C. H. Bowman, K. S. Carlston, E. W. Cleary, R. G. Cohn, J. E. Cribbet, W. H. Davis, G. T. Frampton, W. R. LaFave, J. O'Connell, S. J. Plager, E. F. Scoles, V. J. Stone, J. N. Young.

Associate Professors: P. H. Hay, H. D. Krause.

Assistant Professors: D. C. Baum, P. B. Maggs, R. Reisner.

COURSES FOR GRADUATES

400. **Seminar: Legal Education.** Problems in legal education, curricula, teaching materials, methods of teaching, the place and function of individual courses in the law school program. ½ unit.

499. **Thesis Research.** ½ to 2 units.

PROFESSIONAL COURSES

301. **Contracts A.** Offer and acceptance, consideration, seals, Statute of Frauds. 1 unit (for recommended M.C.L. candidates only). Davis, Hay, Maggs.

302. **Contracts B.** Third-party beneficiaries, assignment, conditions, impossibility, anticipatory repudiation, and discharge; contract and quasi-contract distinguished, and measure of damages for each. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 301. Davis, Hay, Maggs.

303. **Torts A.** Basic course in civil wrongs, including intentional infliction of emotional harm, right of privacy, libel and slander, and unfair commercial practices. ½ unit (for recommended M.C.L. candidates only). Krause, O'Connell.

304. **Torts B.** Basic course in civil wrongs, including negligence, liability without fault, tort liability of owners and occupiers of land, and the impact of insurance on tort liability. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 303. Krause, O'Connell.

305. **Judicial Remedies.** Introduction to civil procedure, common-law forms of action, extraordinary legal remedies, nature of equity jurisprudence, equitable remedies, abolition of the forms of action, fusion of law and equity, statutory remedies. 1 unit (for recommended M.C.L. candidates only). Baum, Stone.

307. **Property A.** The concept of property; acquisition of private property; recognized property interests (personal, real, estates in land). 1 unit (for recommended M.C.L. candidates only). Cribbet, Plager.

308. **Property B.** Gratuitous transfer of property interests; commercial transfers (sale, lease); the use of property. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 307. Cribbet, Plager.

309. **Criminal Law.** The sources and purposes of the criminal law; the meaning of criminal responsibility; the characteristics of particular crimes. 1 unit (for recommended M.C.L. candidates only). Bowman, LaFave.

310. **Constitutional Law.** The apportionment of governmental power between the United States and the states, and the limitations on power resulting from the contract, equal protection, and due process clauses. 1 unit (for recommended M.C.L. candidates only). Reisner, Sullivan.

320. **Business Associations.** The fundamental legal consequences to principals, agents, and third parties of association in various types of business transactions and in various forms of business enterprise. 1 unit (for recommended M.C.L. candidates only). Baum, Frampton.

322. **Commercial Law, I.** A study of the major problems involved in modern commerce, the legal and nonlegal tools that are available for solving these problems, and the traditional solutions which have been hammered out. Particular empha-

sis upon the law of sales, negotiable instruments, banks and banking, letters of credit, bulk sales and fraudulent conveyances, documents of title, and security transactions. 1 unit.

323. **Administrative Law.** The functions of administrative tribunals in federal, state, and municipal government, the procedure before such administrative tribunals, and judicial relief from administrative decisions. 1 unit. COHN.

324. **Corporations.** Promotion and organization of corporations and the rights and liabilities of officers, directors, and shareholders. 1 unit. BAUM, FRAMPTON.

325. **Pleading.** Obtaining information and forming issues in advance of trial. 1 unit. CLEARY.

326. **Evidence.** Principles governing the competency of witnesses and the admissibility of evidence. 1 unit. CLEARY.

328. **Income Taxation.** A study of federal income tax problems relating to business and investment transactions. Subjects treated include the concept of taxable income; allowable deductions; accounting for income and deductions; capital gains; partnership operations; corporate distributions and reorganizations; and tax procedure. 1 unit. YOUNG.

329. **Decedents' Estates and Trusts.** A study of the gratuitous disposition of property by intestacy, by will, and by inter vivos gifts and trusts, including administration of decedents' estates and trusts. 1 unit. PLAGER, SCOLES.

330. **Restitution.** Contractual and quasi-contractual remedies (both legal and equitable) available because of duress, fraud, innocent misrepresentation, mistake, illegality, and economic compulsion in the formation and discharge of contracts and other transactions. 1 unit. DAVIS.

331. **Legislation.** A study of legislative policies and procedures, of legislation as a source of law, of types of statutes and their structure, and of the problems of interpretation. 1 unit. COHN.

333. **Persons.** Creation and dissolution of the family unit and relations between members thereof; marriage, separation, divorce, rights and duties of spouses and means for their enforcement; legal capacity of wife and infant. ½ unit. CARLSTON.

334. **Criminal Law Administration and Procedure.** Problems in the administration of the criminal law; a study of criminal procedure from arrest to the end of the prosecution in a court of review, with emphasis on procedure as a device for social regulation, and including an appraisal of aims and workings of probation, parole, and executive clemency. ½ unit. BOWMAN.

335. **Trials and Appeals.** Litigation from process through appeal, excluding pleading and evidence. 1 unit. STONE.

337. **Commercial Law, II.** Selected problems in modern commercial law and practice. ½ unit.

338. **Insurance.** Personal and property insurance: formation of the insurance relation; concealment, warranties, representations; insurable interests; conditions; subrogation; waiver and estoppel; incontestability; the respective interests of the beneficiary, insured, insurer, assignee, and creditor, and facts constituting maturity in life, accident, fire, theft, liability, and collision policies. 1 unit. DAVIS.

339. **Conflict of Laws.** Problems from conflict of laws in jurisdiction of courts; foreign judgments; torts and workmen's compensation acts; contracts; sales and mortgages; family law; administration of estates; business organizations. 1 unit. HAY, SCOLES.

340. **Municipal Corporations.** Creation and organization; powers; city planning and zoning; liability on contracts and in tort; property rights; revenue and indebtedness. ½ unit. BAUM.

341. **Oil and Gas.** Nature of the property interests in oil and gas; legal interests created by oil and gas leases; validity of leases; the habendum clause; the drilling and

rental clauses; transfer of oil and gas interests; rents and royalties; public regulation of the production of oil and gas. 1 unit.

342. **Mortgages.** A study of real estate mortgages. 1 unit.

343. **Admiralty.** Admiralty and maritime jurisdiction; the maritime lien; carriage of goods; salvage; general average; collision; claims of seamen; limitation of liability; application of state law; sovereign responsibility; choice of law. 1 unit. DAVIS.

344. **Creditors' Rights.** Remedies of the delinquent debtor and his creditors under the Bankruptcy Act; liquidation and rehabilitation; exercises in bankruptcy procedures. 1 unit. BOWMAN.

346. **Future Interests.** A study of the validity and effect of gratuitous dispositions of assets in which enjoyment is postponed, restrained, or long continued; classification of future interests; construction; powers of appointment; rule against perpetuities and related restrictions. 1 unit. SCOLES.

347. **Labor Law.** Same as Labor and Industrial Relations 347. The law of industrial relations with special emphasis on recent cases and legislation; collective bargaining and labor contracts. 1 unit.

348. **International Law.** The nature, sources, and subjects of international law, its place in the control of international society, and an examination of the law of jurisdiction, territory, recognition, and succession of states, rights and immunities of states in foreign courts, diplomatic immunities, treaties, protection of citizens abroad, settlement of international disputes, war and neutrality, the United Nations, and the International Court of Justice. 1 unit. CARLSTON.

349. **State and Local Taxation.** Proper and improper purposes of taxation; the general property tax and its administration; taxpayers' remedies; excise taxes on business concerns and transactions; problems of jurisdiction to tax. ½ unit. YOUNG.

351. **Jurisprudence.** The place of law in society, the goals and methods of law, the nature of law, relation of law and social science. 1 unit. CARLSTON.

352. **Taxation of Gratuitous Transfers.** Various tax problems encountered in the distribution of wealth by inter vivos and testamentary disposition, including a study of federal estate and gift taxes, the Illinois inheritance tax, problems in the assignment of income, and federal income taxes upon estates and trusts. Attention is given to tax planning in the distribution of wealth. ½ unit. YOUNG.

353. **Corporation Finance and Securities.** Drafting provisions of preferred shares; counseling problems requiring written memoranda on the application of state and federal securities laws to the marketing of securities and on the effect of statutes and decisions on distribution of dividends, redemption and purchase of shares, and recapitalization, reorganization, and dissolution of corporations. ½ unit. FRAMPTON.

355. **Trade Regulation.** Antitrust law, control of restrictive business practices, monopoly, unfair competition, trademarks, price discrimination, resale price maintenance, Federal Trade Commission. 1 unit. CARLSTON.

356. **Federal Courts.** The federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state tribunals. 1 unit. STONE.

358. **Social Legislation and the Employee.** Analysis of the legal protection furnished individual employees through workmen's compensation, unemployment compensation, social security, fair labor standards, and similar legislation. 1 unit. O'CONNELL.

359. **Legal History.** The development of the common-law system in England and America: the origin and growth of English legal thought, legal doctrine, and legal institutions; the history of real property, contracts, and torts; the origin and development of courts, legislation, equity, the doctrine of precedent; the evolution of the legal profession; the reception of the common law in America. 1 unit.

369. **Soviet Law.** An examination of Soviet conceptions of the role of law as evidenced both in theory and in practice; emphasis on highlights of Soviet law, with comparison to the common-law and civil-law traditions; study of Soviet court and legislative materials to determine characteristic pattern with respect to: constitution and administration, the relation of the individual with the state and with society; legal regulation of property and productive institutions, private relationships, and international law. 1 unit. MAGGS.

371. **Seminar in Selected Legal Problems.** An introduction to the methods and materials of legal research. The work of the course consists of the discussion of selected topics. In addition, each student investigates a topic approved by the instructor. The results of the investigation are presented orally to the class and submitted in writing to the instructor. The several sections are oriented to different subject matter areas. Credit may be earned in more than one section. ½ unit.

382. **Comparative Law.** A comparative analysis of the three basic institutions of private law: tort, contract, and property. The solutions arrived at in the common-law system are contrasted with the solutions arrived at in the civil-law system and in the Soviet legal system. 1 unit. KRAUSE.

383. **Law and Society.** An examination of some important ideas concerning the nature of law and the role of law in society. 1 unit. REISNER.

387. **International Economic Organizations.** A survey of the principal international economic organizations such as GATT, OECD, ECE, and international monetary and investment institutions (IMF, IBRD, AID); an intensive study of the European Common Market, particularly of its laws relating to trade barriers, establishment of companies, and antitrust; United States legislation in the field of international trade (Trade Expansion Act of 1962). 1 unit. HAY.

399. **Research in Special Topics.** Individual research on a special problem selected in consultation with the instructor. ½ or 1 unit.

LIBRARY SCIENCE

The purpose of the Graduate School of Library Science is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree, certificate of advanced study in librarianship, and the doctor's degree in library science.

Master of Science. Applicants for admission to the Graduate School of Library Science must first be admitted to the Graduate College.

In addition to the Graduate College requirements, applicants to the Graduate School of Library Science must meet the following requirements: (1) a minimum grade-point average of 3.75 for the last sixty hours of academic work completed; (2) one sequence (two semesters) of courses at the college level in each of the three main fields of science, social science, and humanities, and a total of four such sequences in all; (3) a major subject in any field of study, comparable to the undergraduate major at the University of Illinois (at least twenty-four semester hours); (4) two years of college-level study of any foreign languages. This may be either two years of study of one language or one year of each of two languages.

A candidate for the master's degree must complete a prescribed program of undergraduate courses. This requirement may be met by one of the following: (1) completion of a minimum of sixteen semester hours of library science with a grade-point average of at least 4.0 in an institution approved by the Graduate School of Library Science; (2) completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, in the Graduate School of Library Science with a grade-point average of at least 3.75. Exemption from one or more of these courses may be secured by a satisfactory score on a comprehensive examination which is offered on the day preceding the opening of registration each semester and summer session. There is a special offering of these four courses each eight-week summer session,

enabling beginning students to complete the entire preparatory sequence before taking regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

At least two semesters in residence—or the equivalent—are required to earn the master's degree, in addition to attendance in preparatory courses. In this period, eight units of graduate study should be completed. Each student's program of study, adapted to his particular needs and purposes, is planned in consultation with an adviser at the time of original registration and thereafter. Students who have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to complete Library Science 405, 407, and 411 or 412, and one of the 300-level literature courses. No thesis is required, but to insure that every candidate for a master's degree will have satisfactorily demonstrated his ability to assemble, organize, and present information and ideas in acceptable written form, the Graduate School of Library Science requires each student to prepare a formal term paper, designated as the master's project, in one of his library science courses.

Students interested in the Advanced Master's program, the Certificate of Advanced Study in Librarianship, and the Doctor of Philosophy degree should write to the Director of the Graduate School of Library Science, 329 Library.

GRADUATE FACULTY

Professors: R. B. Downs (Dean of Library Administration), H. Goldhor (Director of Graduate School of Library Science), H. Goldstein, Frances B. Jenkins, R. F. Stevens.

Associate Professors: G. G. Garrison, Winifred C. Ladley, M. Alice Lohrer.

Assistant Professor: Cora E. Thomassen.

COURSES FOR GRADUATES

402. **Studies in Reading.** Designed to acquaint students with the major areas of investigation and interest in reading. Special attention is given to studies of reading interests and habits of children, youth, and adults. Class discussions are devoted to analysis of various studies and their implications for library service and classroom teaching. 1 unit. Ladley, Lohrer.

403. **Methods of Investigation in Librarianship.** Survey of library literature, with attention to examples of research in the library field, to elementary statistical procedures, and to the methods of investigation applicable to librarianship. Designed to prepare consumers rather than producers of research results. 1 unit. Jenkins.

405. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. 1 unit. Goldstein.

406. **Library Service to Children and Young Adults.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young adults in the public library. 1 unit. Credit is not given for Library Science 406 in addition to credit in Library Science 307. Prerequisite: Library Science 204 or 405. Ladley, Lohrer.

407. **Cataloging and Classification, I.** The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and the Library of Congress subject headings. 1 unit. Field, Henderson.

408. **Cataloging and Classification, II.** The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. 1 unit. Prerequisite: Library Science 407. FIELD, HENDERSON.

409. **Communication Roles and Responsibilities of Libraries.** Mass media of communication are considered in terms of their relations with modern library services; media organization, content, and research are reviewed; problems of intellectual freedom are considered as an aspect of communications behavior; and the potential role of electronic devices in library activities now and for the future is discussed. 1 unit. GOLDSTEIN.

410. **Adult Education and Libraries.** The literature, history, and problems of adult education in the United States are presented in relation to the role of the library as an educational agency. Students study organization for adult education in the community and become familiar with the significant methods and materials used in a variety of educational programs. 1 unit. GOLDSTEIN.

411. **Reference Service in the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in some ten subject fields, with training and practice in their use for solving questions arising in reference service. 1 unit. STEVENS.

412. **Science Reference Service.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. 1 unit. JENKINS.

424. **Government Publications.** The nature and scope of American and British government publications; the problems of organizations arising from their form and from the methods of their production and distribution. 1 unit. Prerequisite: Library Science 411 or 412, or consent of instructor. FIELD.

427. **Resources of American Research Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; spatial and financial aspects of library resources; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; and ways and means of developing research collections in special subject fields. 1 unit. STEVENS.

428. **Library Buildings.** A study of the library's physical plant in the light of changing concepts and patterns of library service. Present-day library buildings, both new and remodeled, are analyzed and compared with each other as well as with buildings of the past. The interrelationship of staff, collections, users, and physical plant is examined in detail. Class discussion is supplemented by visits to new libraries and conferences with their staffs. 1 unit. Prerequisite: Library Science 405 or consent of instructor. GARRISON.

429. **Information Storage and Retrieval.** Analyzes the problems which confront libraries and library users as a result of the growth of literature; reviews the various systems for storing and retrieving information; introduces the underlying models and basic types of equipment for both traditional and non-conventional systems; emphasizes practical applications in libraries. 1 unit. Prerequisite: Library Science 405; consent of instructor. CARROLL.

430. **Advanced Reference.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. 1 unit. Prerequisite: Library Science 424 or consent of instructor. CARROLL.

431. **History of Libraries.** The development of libraries from those of Nineveh to the present day. Includes the Hellenic libraries, Roman libraries, monastery libraries of the Middle Ages; the work of the great book collectors in building up collections which were turned over to national libraries; the development of the great private, academic, and tax-supported libraries which survive today. ½ or 1 unit. STEVENS.

432. **History of Books and Printing.** Same as Communications 432. The origin and evolution of the alphabet and of scripts; the history of manuscript books; the invention and spread of printing; the account of the production and distribution of printed books. Emphasis is placed on the relation of books to social conditions in the various periods studied. 1 unit. STEVENS.

433. **Advanced Subject Bibliography.** A study of the literature, information sources, and reference aids in various specialized fields of knowledge, identified as different sections of this course, from the point of view of their use by librarians. No student may take more than two different sections for credit toward a degree: (a) architecture, (b) biology, (c) chemistry, (d) education and psychology, (e) engineering, (f) journalism and communications, (g) law, (h) maps, (i) music, (j) mathematics, (k) Slavic. ½ unit. Prerequisite: Consent of instructor. STAFF.

434. **Library Systems.** Considers the development of library systems, with special reference to public libraries as a norm for the development of library services: library standards, the growth and development of county and regional libraries, the role of the state library and of federal legislation are among the topics treated in detail. 1 unit. Prerequisite: Library Science 405 or consent of instructor. GOLDSTEIN.

436. **Development of the Library Catalog.** The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor. FIELD.

439. **Medical Literature and Reference Work.** Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources. 1 unit. Prerequisite: Consent of instructor.

441. **History of Children's Literature.** Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. 1 unit. LOHRER.

443. **Contemporary Book Publishing.** Survey of twentieth-century book publishing, particularly in America, placing it in an economic, social, and literary context. Emphasis is on production, technological developments, economic structure, methods of distribution and promotion, and book publishing as an art. 1 unit. BLUM.

COURSES FOR ADVANCED GRADUATES

450. **Advanced Studies in Librarianship.** Directed and supervised investigation of selected problems in library resources, reference service. research libraries, reading, public libraries, or school libraries. ½ to 2 units. Prerequisite: Fifth-year degree in library science; consent of director. STAFF.

462. **History of Education for Librarianship.** A study of the origin and development of library science education in this country and abroad; emphasis is placed on the major events and activities which led to the present status of library school programs. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. GOLDSTEIN.

463. **Current Developments in Technical Services.** An examination of changing policies and procedures in the administration of acquisitions, cataloging, binding, photographic reproduction, and related areas. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STEVENS.

465. **Librarianship and Society.** Analysis of the role and functions of libraries in the twentieth century; the changing characteristics of information and knowledge are viewed as major determinants of libraries' relations to society. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. GOLDSTEIN.

469. **Principles of Research Methods.** Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. 1 unit. Prerequisite: Knowledge of the principles of statistics, Master of Science in Library Science, or consent of instructor. GOLDHOR.

499. **Thesis Research.** Individual study and research. Section A: M.S. candidates, 0 to 2 units. Section B: Ph.D. candidates, 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Literature of the Humanities and Social Sciences.** This course is designed to build a knowledge of the scope and significant characteristics of the several fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. 1 unit. CARROLL.

302. **Literature of the Sciences.** An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. 1 unit. JENKINS.

303. **Library Materials for Children.** The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, social, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. Credit is not given for Library Science 303 in addition to credit in Library Science 307. ½ or 1 unit. BEKKEDAL, LADLEY, LOHRER, THOMASSEN.

304. **Library Materials for Young Adults.** The selection and use of library materials for the young adult in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. Credit is not given for Library Science 304 in addition to credit in Library Science 307. ½ or 1 unit. HJORT, LADLEY, LOHRER, THOMASSEN.

307. **Library Materials and Services for Children and Young Adults.** A nonspecialist's view of the materials and services involved in work with children and young adults, including a brief survey of print and nonprint materials for children and young people, and basic guidelines for library services to them. Credit is not given for Library Science 307 in addition to credit in Library Science 303, 304, 309, or 406. 3 hours or 1 unit.

308. **Audio-Visual Services in Libraries.** Designed to acquaint students with the typical audio-visual programs and responsibilities of libraries. Group activities stress, through presentation and evaluation, the use of materials and related equipment necessary for film, radio and television, exhibit and other programs

of libraries. The practices of audio-visual departments in libraries are reviewed and evaluated. 1 unit. BEEBE.

309. **Storytelling.** Fundamental principles of the art of storytelling including techniques of adaptation and presentation for children of various ages. Content and sources of materials; story cycles; methods of learning practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and for television. Open to undergraduates and non-Graduate School of Library Science students. Credit is not given for Library Science 309 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY.

LIFE SCIENCES

The School of Life Sciences is a unit of the College of Liberal Arts and Sciences and includes the Departments of Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology. Study programs leading to the graduate degrees of Master of Science and Doctor of Philosophy exist in each of the departments and are described in detail in the following pages. Interdepartmental study programs leading to advanced degrees in cell biology and virology, and developmental biology, are administered within the School. The School also participates with other departments of the University in offering the Ph.D. program in genetics (see page 172) and with the Department of Chemistry and Chemical Engineering in offering a program in biophysical chemistry (see page 92). Applicants who desire to enter any of the graduate study programs are usually required to have earned a grade-point average of at least 4.0 for their last sixty hours of undergraduate work. In certain programs, applicants with a grade-point average between 3.5 and 4.0 are considered by a special committee.

Support for graduate training is available in the form of teaching or research assistantships, University fellowships, or trainee fellowships. Prospective students may obtain application forms and relevant information for departmental study programs from the executive officer of the appropriate department, or for interdepartmental study programs from the Director of the School of Life Sciences.

INTERDEPARTMENTAL STUDY PROGRAMS

Master of Science in the Teaching of the Biological Sciences and General Science. This degree is offered with the completion of the fifth year in the teacher-education curriculum in biological and general science. The degree is primarily intended for but not restricted to certified teachers of biology and general science in junior high school, high school, and junior college. For admission to this degree program, students must have a grade-point average of at least 3.5.

Candidates for the Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. Electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry is strongly advised. The adviser for candidates for this degree is Professor Wilson N. Stewart, 154b Natural History Building.

Master of Science in Biology. A program of study leading to the master's degree in biology is designed for individuals who (1) wish additional training at the master's level for professional proficiency in teaching or research, (2) desire to continue to the Ph.D. degree, possibly in one of the programs sponsored by the School of Life Sciences, or (3) do not wish to limit their training to a single area of biology.

Applications from individuals with grade-point averages between 3.5 and 4.0 must be accompanied by a three-hundred word essay by the applicant outlining his educational objectives.

Although no specific undergraduate courses are required for admission to this curriculum, a year of physics and a course in organic chemistry must be completed before a degree is granted.

Candidates for the degree are advised to obtain a broad, basic training in biology and are examined in aspects of cellular, organismic, and population biology. Of the eight units required for the degree, at least one unit must be taken in 400-level courses. A thesis is not required, but at least one course must be included in which individual problems are assigned. A comprehensive examination is required of all candidates for the degree.

Students who are preparing themselves for high school teaching and who are not yet certified must fulfill state certification requirements.

Doctor of Philosophy in Biology. The School of Life Sciences offers Ph.D. programs in two specified interdepartmental areas, cell biology and virology, and developmental biology. Entrance requirements, in addition to those listed above for the M.S. program, include background training in general biology, physics, biochemistry, and calculus, but deficiences in these areas may be remedied during the first year of graduate study. Study programs are designed to suit individual needs in consultation with advisers. Descriptions of the area programs are given below.

Students who have been accepted for one of these programs may select any faculty member in the School of Life Sciences, or an appropriate member of the Biochemistry Division as a major adviser. Additional information may be obtained from the Director of the School of Life Sciences.

CELL BIOLOGY AND VIROLOGY

The cell biology and virology program emphasizes molecular mechanisms and is therefore addressed to students who have acquired or wish to acquire a strong background in chemistry. Areas of research open to students in this program include cytochemistry, biochemistry of subcellular systems, cellular differentiation, intracellular regulation of meiosis and mitosis, circadian rhythms, cellular genetics, and virology.

DEVELOPMENTAL BIOLOGY

The developmental biology program emphasizes the study of developmental processes in cells, tissues, and organ systems. Training in the techniques of cytochemistry, histochemistry, cell fractionation, electron microscopy, microspectrophotometry, microelectrophoresis, immunology, tissue culture, and transplantation of tissues and organs are provided as required.

In addition to the entrance requirements, students are required to complete courses in embryology, cytology-histology, and genetics.

Biology

The following courses are administered directly by the School of Life Sciences. These courses, as is the case with departmental courses, are applicable to the study programs within the School.

COURSES FOR GRADUATES

409. **History of Biology.** The development of biological concepts from the classical Greek period to the present. 1 unit. Prerequisite: Consent of instructor.

423. **Electron Microscopy.** Same as Chemistry and Zoology 423. Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Open to qualified graduate students in any department. ¼ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; consent of instructor. HALL.

429. **Electron Microscopy Laboratory.** Same as Chemistry and Zoology 429. Essentially individual instruction. Detailed training in operation and care of electron microscopes (four types); preparation of specimens including microtomy, electron staining, replication, and shadow casting; measurements and interpretations; special projects related to student's research interests. Open to qualified graduate students in any department. ½ or ¾ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; credit or registration in Biology 423; consent of instructor. HALL, PAGE.

490. **Special Topics in Biology.** Individual topics in research and/or reading conducted under the supervision of faculty members in the School of Life Sciences. This course is particularly designed for students enrolled in the biology program who would like to become more familiar with specialized fields of study prior to committing themselves to a specific area for their doctorate degree. 0 to 1 unit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. **Population Biology.** A study of problems associated with the behavior of plant and animal populations based on genetic, evolutionary, and ecological principles. ¾ unit. Prerequisite: Biology 151 and 251, and/or consent of instructor. GHENT.

371. **Quantitative Biology.** Theory and practical application in biology of probability and statistics. Lectures and assigned problems. ¾ unit. Prerequisite: College algebra; consent of instructor.

DEPARTMENTAL STUDY PROGRAMS AND COURSES

Botany

The Department of Botany offers graduate work leading to the Master of Science and Doctor of Philosophy. Candidates for advanced degrees must have had at least twenty hours of undergraduate work in botany, or fifteen hours in botany and five hours in a related subject acceptable to the department. The applicant's grade-point average must be at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The following subjects comprise a partial listing of the areas of specialization available in the department: cytology, cytogenetics, anatomy, morphology, morphogenesis, paleobotany, ecology, plant geography, taxonomy, cytotaxonomy, physiology (including photosynthesis), physiological genetics, mycology, phycology, virology, and ultrastructure.

Courses offered in the departments of Agronomy, Chemistry and Chemical Engineering, Entomology, Geography, Geology, Horticulture, Mathematics, Microbiology, Physics, Physiology and Biophysics, Plant Pathology, and Zoology are available to advanced students and offer a broad foundation for botanical work. Graduate students in botany may elect their minor subjects in one or two of these fields.

Special Facilities. Graduate students may avail themselves of the University herbarium which contains 500,000 specimens of vascular plants, bryophytes, algae, fungi, and fossil plants. As field laboratories, the University maintains two tracts of woodland, Brownfield Woods and Trelease Woods; in addition, certain areas of Robert Allerton Park near Monticello have been designated for research and study. Greenhouses, garden plots, and growth chambers are maintained for experimental work with living plants. Well equipped laboratories are available for each area of specialization within the department. The Maize Genetics Research Laboratory maintains an extensive collection of maize genetic stocks adapted to the North Central states; the College of Agriculture and the Agricultural Experiment Station offer ex-

ceptional facilities to graduate students in plant genetics, plant pathology, and in some of the other plant sciences. The Biology Library, with over 70,000 volumes, offers excellent library facilities, with bibliographical aids including the Gray Herbarium Card Index of American Plants, the Index of American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis.

Departmental Qualifying Examination. A written qualifying examination must be taken by all new graduate students majoring in botany at the beginning of their first semester. This examination is offered in the week prior to the opening of the first or fall semester and in the week prior to the opening of the second or spring semester. The examination is used to determine the level of information in the following areas: (1) ecology, (2) genetics, (3) morphology, (4) physiology, and (5) taxonomy. The results of the examination are used by the departmental qualifying examination committee and the student's adviser to recommend future graduate courses, and no permanent record is made of the results.

Students with deficient preparation in any one of the five areas can remove the deficieny: (1) by passing an examination in the deficient areas or substitute areas after a period of independent reading and study; (2) by registration in a course in the field of deficiency and by passing the course with a grade of B or better; (3) by substitution of courses in botany, approved by the qualifying examination committee and the adviser. A limit of two substitutions is allowed for each student.

Master of Science. During their graduate or advanced undergraduate work, candidates for this degree must have completed courses in the following basic fields of botany: (1) taxonomy (Botany 460 or equivalent), (2) morphology (Botany 302 and 303, or equivalent), (3) ecology or plant geography (Botany 381 or equivalent), (4) genetics (Botany 210 or equivalent), (5) physiology (Botany 330 or equivalent).

A thesis is not required of candidates for the Master of Science except at the option of the graduate student's major adviser. Graduate students do not receive credit toward the master's degree in Botany 499 unless they write acceptable master's theses. A student may engage in graduate work toward the Doctor of Philosophy without having obtained a master's degree.

Doctor of Philosophy. Candidates for this degree must complete the course requirements listed above before receiving the Doctor of Philosophy. Having satisfied these basic course requirements imposed by the qualifying examination, the candidate for the doctor's degree may elect whatever other graduate courses he desires, subject to the approval of his major adviser and to the general regulations of the Graduate College concerning requirements in his major and minor fields (see pages 41 to 44.

GRADUATE FACULTY

Professors: L. M. Black, L. C. Bliss, H. J. Fuller, J. B. Hanson, G. N. Jones, J. R. Laughnan, E. I. Rabinowitch, M. E. Reichmann, D. P. Rogers, D. M. Steffensen, W. N. Stewart.

Associate Professors: J. F. Nance (Acting Head of Department), Z. B. Carothers, Govindjee, D. Paolillo.

Assistant Professors: L. R. Hoffman, W. W. Payne.

COURSES FOR GRADUATES

402. **Molecular Genetics.** See Zoology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

403. **Physiology of Fungi.** Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Organic chemistry or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

405. **Microbiological Genetics.** See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. ATWOOD, NANNEY, SPIEGELMAN.

410. **Botany Discussions.** All graduate students in botany, except those with conflicting teaching assignments, are required to register in and attend the general seminar. No credit is given except to those students presenting the results of their Ph.D. thesis research. 0 or ¼ unit. STAFF.

411. **Discussions in Genetics and Cytogenetics.** Same as Microbiology and Zoology 411. ¼ unit. BADER, BROWN, DRAKE, KITZMILLER, LAUGHNAN, NANNEY, STEFFENSEN.

413. **Discussions in Plant Physiology.** ¼ unit. NANCE.

414. **Discussions in Plant Morphology and Taxonomy.** ¼ unit. STAFF.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. ¼ unit. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. BLISS.

419. **Discussions in Photosynthesis and Related Topics.** ¼ unit. Prerequisite: Consent of instructor. GOVINDJEE, RABINOWITCH.

421. **Cytogenetics.** Same as Zoology 421. Chromosome theory: the structure, behavior, and physiology of chromosomes in heredity and development. 1 unit. Prerequisite: Botany 210, or Microbiology 330, or consent of instructor. STEFFENSEN.

424. **Mineral Nutrition of Plants.** Same as Agronomy and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

427. **Discussions in Mycology.** A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. ¼ unit. Prerequisite: Consent of instructor. ROGERS.

433. **Advanced Physiology of Growth, Responses, and Reproduction.** 1 unit. Prerequisite: Botany 330 or equivalent. HANSON, MCCOLLUM, NANCE, WILSON.

436. **Principles in Plant Physiology.** A laboratory course illustrated by experiments with algae and including experiments on the nutrition of algae, photosynthesis, respiration, and enzyme processes; special emphasis is on photosynthesis. Enrollment limited to six students. 1 unit. Prerequisite: At least one course at the college level in each of the following: biology, chemistry, and physics (or physical chemistry) . GOVINDJEE.

450. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. HOFFMAN.

460. **Advanced Taxonomy of Flowering Plants, I.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Botany 160 or one year of botany or another biological science, or consent of instructor. JONES.

461. **Advanced Taxonomy of Flowering Plants, II.** The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Botany 160 and 210, or equivalent; consent of instructor. PAYNE.

471. **Advanced Mycology: Special Groups.** The several classes of fungi and their activities are considered in successive semesters. Special groups within these classes may be selected for concentrated study, depending upon the student's interest in mycology. ½ unit. Prerequisite: Botany 372 or consent of instructor. ROGERS.

493. **Advanced Studies in Botany.** ½ to 2 units. Not more than one unit may be applied toward the Graduate College master's degree requirement of three units of course work at the 400 level. Work may be taken in the following fields:
   (a) **Anatomy.** Carothers, Paolillo.
   (b) **Bryology.** Jones.
   (c) **Cytogenetics.** Steffensen.
   (d) **Cytology.** Steffensen.
   (e) **Ecology.** Bliss.
   (f) **Genetics.** Laughnan.
   (g) **Morphogenesis.** Paolillo.
   (h) **Morphology.** Carothers, Phillips, Stewart.
   (i) **Mycology.** Rogers.
   (j) **Paleobotany.** Phillips, Stewart.
   (k) **Photosynthesis.** Govindjee, Rabinowitch.
   (l) **Phycology.** Hoffman.
   (m) **Physiology.** Hanson, Nance.
   (n) **Taxonomy.** Jones, Payne.
   (o) **Ultrastructure.** Carothers, Hoffman, Paolillo.
   (p) **Virology.** Black, Reichmann.

499. **Thesis Research.** Individual work under supervision of member of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. Staff.

301. **Plant Pathology.** Same as Plant Pathology 301. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. 1 unit. Prerequisite: One year of plant science, including Botany 100. Bever, Staff.

302. **Comparative Morphology: Nonvascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, and bryophytes. Students receiving credit for Botany 302 do not receive credit for Botany 304. ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. Hoffman, Phillips, Rogers, Stewart.

303. **Comparative Morphology: Vascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative vascular plants, including psilopsids, lycopsids, sphenopsids, ferns, gymnosperms, and angiosperms. Students receiving credit for Botany 303 do not receive credit for Botany 304. ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. Phillips.

304. **General Plant Morphology.** A survey of the principles of plant morphology as exemplified by the various plant groups. Modification of course is made to meet the needs of teachers and prospective teachers. Students receiving credit for Botany 304 do not receive credit for Botany 302 or 303. S; ½ or 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent; consent of instructor. Staff.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. This course adjusted to professional semester (practice teaching) for students in teacher-training curriculum. Two four-hour field trips to be given on Saturdays. ½ unit. Prerequisite: Botany 100 and Zoology 104, or a one-year course in general biology; expectation of teaching. Staff.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. ALGER, SILVERMAN.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. ALGER, SILVERMAN.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. STAFF.

330. **Intermediate Plant Physiology.** A lecture and laboratory course dealing with the principles of plant physiology at an intermediate level. For students majoring in botany and others primarily interested in the plant sciences. 1 unit. Prerequisite: One year of biology; one semester of organic chemistry. NANCE.

331. **Experimental Cytology.** Same as Zoology 331. Organization of cells of higher organisms with emphasis on the relationships between structure and function. The laboratory stresses modern cellular techniques. 1 unit. Prerequisite: Botany or Zoology 210 or Biology 151 and 251; consent of instructor; biochemistry is recommended. DAVENPORT, STEFFENSEN.

340. **Histological Technique.** Survey of techniques used in the preparation of plant tissues for microscopical examination. 1 unit. Prerequisite: One year of botany or ten hours of zoology; consent of instructor. PAOLILLO.

341. **Field Ecology.** Study of plant communities in various sections of North America during spring vacation (trips rotate on a three-to-five-year basis); outdoor cooking and camping; transportation in University cars. ¼ unit; may be repeated for a maximum of ¾ unit. Prerequisite: One of the following—Botany 160, 366, 381, 385; consent of instructor. BLISS.

345. **Plant Anatomy.** Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. 1 unit. Prerequisite: One year of Botany. CAROTHERS.

366. **Field Botany.** Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. STAFF.

372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. 1 unit. Prerequisite: One year of botany, entomology, microbiology, or zoology. ROGERS.

381. **Plant Ecology.** Principles of ecology, exemplified by vegetation and environments of Illinois. 1 unit. Prerequisite: Botany 160 or equivalent. BLISS.

382. **Ecological Methods.** Field methods used in plant ecology. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: One year of botany including Botany 381 or equivalent. BLISS.

385. **Plant Geography of North America.** Vegetation regions and principal subdivisions; environments, plant cover, floras. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Botany 381 or equivalent; one course in geology is recommended. BLISS.

Entomology

The Department of Entomology offers graduate work leading to the Master of Science and Doctor of Philosophy. Admission requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology gain a thorough grounding in the fundamentals of physical and biological science, mathematics, and the liberal arts.

Candidates for the Master of Science in Entomology are required to earn two units in a basic sequence that includes the fundamentals of insect morphology, physiology, and taxonomy, plus one unit each in more advanced courses in insect morphology, physiology, and control. Electives make up the balance of the eight-unit requirement. Not more than two units of research credit may be elected, and if research credit is presented, a thesis is required. The candidate must pass an oral examination covering the general field of entomology.

Candidates for the Doctor of Philosophy in Entomology must satisfy the department course requirements for the master's degree and must also earn one unit of credit in insect bionomics and one unit in insect taxonomy. The remainder of their program is made up of electives.

The chief fields of specialization in the department are: general entomology (including morphology and taxonomy), insect bionomics, applied entomology (including economic entomology and medical entomology), toxicology of insecticides, and insect physiology. The department is well equipped to offer work in these areas, and the facilities of the State Natural History Survey are also available for advanced study. Outstanding entomological library facilities are located on the campus.

The requirements of the department in regard to minors are the following: For a sole minor, four units must be taken outside the department in one of the following areas: agronomy, botany (including plant pathology), chemistry, horticulture, microbiology, physiology, and zoology. A first minor (two units) may be taken in a field of specialization in entomology other than the major, and the second minor (two units) must be in a related subject outside the department. For minors outside the Department of Entomology, the candidate should in all cases check the requirements both with his adviser and with the department concerned.

GRADUATE FACULTY

Professors: C. W. Kearns (Head of Department), G. Fraenkel, W. R. Horsfall, H. H. Ross, R. B. Selander, J. G. Sternburg.

Associate Professors: A. W. Ghent, S. Friedman, E. R. Jaycox, J. R. Larsen, G. P. Waldbauer.

COURSES FOR GRADUATES

410. **Insect Morphology.** A comprehensive study of the internal and external structure of insects, from the comparative viewpoint. 1 unit. Prerequisite: Entomology 301. Sternburg.

413. **Medical and Veterinary Entomology.** Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. 1 unit. Prerequisite: Entomology 101, 103, or 301; or Zoology 320. Horsfall.

420. **Chemistry and Toxicology of Insecticides.** Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. 1 unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. Kearns, Sternburg.

422. **Insect Physiology.** A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. 1 unit. Prerequisite: Entomology 301; a course in organic chemistry. Friedman, Larsen.

423. **Insect Behavior.** An analysis of the physiological basis of insect behavior, including a thorough study of the various sensory systems. 1 unit. Prerequisite: Entomology 301. Waldbauer.

426. **Seminar in Entomology.** Discussions, reviews, and appraisals of special topics in the field of entomology. 1/4 to 1 unit. Prerequisite: Entomology 302; consent of

instructor. Fraenkel, Friedman, Horsfall, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer.

430. **Biological Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. Hall.

499. **Thesis Research.** Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and ecology of insects, insect toxicology, and insect physiology. 0 to 4 units. Fraenkel, Friedman, Ghent, Horsfall, Jaycox, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Advanced Entomology, I.** With Entomology 302, this course provides the necessary background for all further advanced work in the department. Entomology 301 is devoted to integrated studies of the principal morphological and physiological characteristics of insects, and is to be followed by similar systematic studies in Entomology 302. 1 unit. Prerequisite: Zoology 101, Botany 100 and Chemistry 101, or equivalent. Friedman, Sternburg.

302. **Introduction to Advanced Entomology, II.** With Entomology 301, this course provides the necessary background for all further advanced work in the department. Entomology 302 presents a comprehensive survey of the systematics and phylogeny of the orders and principal families of insects, together with practical experience in identification of these taxa. 1 unit. Prerequisite: Entomology 301. Selander.

306. **Special Problems.** For students ready to take up some special investigation as the beginning of a thesis problem for an advanced degree. ¼ to 1 unit. Prerequisite: Any of the following: Entomology 131, 301, 302, 317, 319, 322, or Zoology 101 or 321. Fraenkel, Friedman, Ghent, Horsfall, Jaycox, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. Alger, Silverman.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307 and consent of instructor. Alger, Silverman.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelation with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent.

317. **Classification of Insects.** Advanced study of the systematics and phylogeny of selected insect groups, with a presentation of the principles and methods of systematic entomology. 1 unit. Prerequisite: Entomology 302. Selander.

319. **Fundamentals of Insect Control.** The course emphasizes the principles that underlie effective control practices, rather than the details of methods used against specific pests. Both environmental and chemical factors involved in insect control are considered from their basic aspects. 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalent. Horsfall, Kearns.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. 1 unit. Prerequisite: Entomology 101, 103, or 301, or Zoology 320. Horsfall.

361. **Individual and Group Behavior of Honey Bees.** See Horticulture 361. ½ unit. Prerequisite: One semester of entomology or zoology. Jaycox.

Microbiology

The Department of Microbiology offers graduate work leading to the Master of Science and Doctor of Philosophy. Students electing microbiology as a major for an advanced degree must have had, in addition to formal training in general bacteriology or microbiology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these requirements may apply for admission if they have a grade-point average of at least 4.0.

Candidates for the Master of Science must pass a general comprehensive examination.

MOLECULAR BIOLOGY (Biophysical Chemistry)

The Department of Microbiology in collaboration with the Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the doctoral candidate with basic training in physical biochemistry and biology. Students electing this area should possess a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interests of the student. It is expected, however, that he will fulfill minor requirements in physical chemistry or biochemistry.

Courses in the Department of Microbiology directly relevant to this program are Microbiology 330, 351, 405, and 494 (same as Chemistry 494) . Courses in the Department of Chemistry and Chemical Engineering especially related to this curriculum are Chemistry 346, 452, 494.

The major research areas are: (1) molecular basis of gene function; (2) structures and activities of proteins and nucleic acids; (3) intracellular organization and distribution of nucleoprotein components; (4) biosynthetic mechanisms of macromolecular replication; (5) immunochemistry.

GRADUATE FACULTY

Professors: L. L. Campbell (Head of Department) , K. C. Atwood, F. M. Clark, R. D. DeMoss, R. E. Kallio, A. Nisonoff, S. Spiegelman, R. S. Wolfe.

Associate Professors: J. W. Drake, J. T. Wachsman, C. R. Woese, M. J. Wolin.

Assistant Professor: P. S. Sypherd.

COURSES FOR GRADUATES

402. **Molecular Genetics.** Same as Botany and Zoology 402. The nature of the gene, its mode of action, the mechanism of autosynthesis, the organization of the genetic material, and the regulation of gene action. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. **Microbiological Genetics.** Same as Botany and Zoology 405. Breeding systems and recombinational analysis in microorganisms, with particular emphasis on protozoa and fungi. ¾ unit. Prerequisite: Microbiology 330: mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

411. **Discussion in Genetics and Cytogenetics.** Same as Botany and Zoology 411. ¼ unit. Drake, Kitzmiller, Laughnan, Nanney, Steffensen.

412. **Advances in Microbiology.** Discussions of current research in several areas of microbiology. Discussions cover the following areas: (a) general microbiology, (b) microbial physiology and metabolism, (c) immunochemistry, (d) molecular genetics. ¼ unit. May be repeated for a maximum of one unit. Prerequisite: Consent of instructor.

420. **Chemistry of Microbic Processes.** The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimulation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. ¾ unit. Prerequisite: Microbiology 309 or 330 and Chemistry 234 and 350, or equivalent; consent of instructor. DeMoss.

430. **Biology Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. Hall.

451. **Experimental Virology.** Experiments to illustrate the main properties of viruses. ¾ unit. Prerequisite: Microbiology 351; consent of instructor. Drake.

490. **Individual Problems.** ½ to 2 units. Prerequisite: Consent of instructor. Staff.

494. **Chemical Basis of Biological Specificity.** Same as Chemistry 494. Biological formation and interaction of large molecules; an analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles; nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; and metabolic interrelations of these molecules. ¾ unit. Prerequisite: Chemistry 344, 346 and 350, or 450; Microbiology 330; or consent of instructor. Nisonoff, Weber.

495. **Seminar.** Required of all graduate students whose major is microbiology. 0 or ¼ unit. Prerequisite: Ten hours of microbiology; consent of instructor. Staff.

499. **Thesis Research.** 0 to 4 units. Atwood, Campbell, Clark, DeMoss, Drake, Gunsalus, Kallio, Nisonoff, Spiegelman, Wachsman, Woese, Wolfe, Wolin.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. Alger, Silverman.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. Alger, Silverman.

309. **Cultivation and Properties of Microorganisms.** Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, cultivation of bacteria, and microbiological assays. 1 unit. Prerequisite: Organic chemistry, with biochemistry recommended; consent of instructor. Wolfe, Wolin.

311. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation and to industrial fermentation and processing and to sanitation. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201 or 309, or equivalent, and credit or registration in organic chemistry; or consent of instructor. Clark.

312. **Techniques of Applied Microbiology.** A consideration, through experimentation, of the properties of the bacteria, yeasts, molds, and actinomycetes which are important to industrial processes. The methods of control of microbial processes in industry and sanitation are explored. Laboratory. ½ unit. Prerequisite: Credit or registration in Microbiology 311. Clark.

326. **Pathogenic Bacteriology.** A study of the parasitism and pathogenic microorganisms: classification, morphology, cultural requirements and reactions, toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lectures and laboratory. 1 unit. Prerequisite: Microbiology 101 or 201, or 309; organic chemistry. McCamish.

327. **Immunochemistry.** A survey of the field of immunology with emphasis on its chemical aspects. Lectures and laboratory. 1 unit. Prerequisite: Credit or registration in biochemistry or consent of instructor. Nisonoff.

330. **Metabolic Regulation and Genetics of Microorganisms.** Modern contributions to the science of microbiology, including considerations of the micro- and macromolecular anatomy of the bacterial cell, the physiological and genetic behavior of microorganisms, and the role of bacterial viruses as agents involved in the transfer of genetic information. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201, or equivalent; credit or registration in biochemistry or consent of instructor; calculus strongly recommended. SYPHERD, WOESE.

351. **Viruses.** The study of viruses as a branch of microbiology. Statistical, physical, and chemical properties of virus particles; analysis of host-virus interaction; origin and natural relations of viruses. ¾ unit. Prerequisite: Organic chemistry; biochemistry recommended. DRAKE.

Physiology and Biophysics

The Master of Science and Doctor of Philosophy are granted in both physiology and biophysics.

Physiology

Admission to graduate study in physiology requires a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Applicants should submit three letters of recommendation, a letter regarding intentions and qualifications, and, if possible, scores on the Graduate Record Examination. There is no departmental requirement of specific undergraduate major or minor fields, but the student whose background is deficient in chemistry, mathematics (including calculus), physics, or biological sciences (including morphology and genetics) must rectify these deficiencies early in his graduate career. Students who have not had a laboratory course in physiology should take Physiology 301 or 302 before they enter the graduate courses in advanced physiology.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in physiology and related subjects. Ordinarily, the program includes Physiology 401, 402, 403, and 404, two units from related departments, and two units of Physiology 491. A research paper based on Physiology 491 must be submitted. Candidates for the Master of Science must pass a general oral examination.

Doctor of Philosophy. Admission to candidacy is based on a qualifying examination after completion of eight units or the Master of Science.

The department requires that the candidate pass a written comprehensive examination covering important areas of physiology before he is permitted to take his oral preliminary examination. Five papers are required: one each in general mammalian physiology, comparative physiology, and cellular physiology; one on his minor area; and one on physiological concepts related to his special area.

Each candidate must take, either as an undergraduate or as a graduate student, the following courses or their equivalents: Physiology 401, 402, 403, and 404 (combined mammalian, cellular, and comparative physiology); Chemistry 340 or 342 and 344; Chemistry 350 and 355; a course in statistics at the graduate level; and a course in the history and/or the philosophy of science. At some time during the doctoral program, the candidate will be expected to teach for two semesters at half time (or the equivalent).

In addition to satisfying the above requirements for all students, each candidate specializes in one of the following areas: mammalian physiology, comparative physiology, cellular physiology, endocrinology, neurophysiology, human anatomy and human physiology, bioclimatology and environmental physiology, radiobiology. An intradepartmental minor may be offered in most of these areas of specialization, chosen from sequences other than Physiology 401, 402, 403, and 404.

Minor. Graduate students in other departments are assigned by the physiology graduate student counselor to a departmental minor adviser according to their interests. Requirements are as follows: sole minor, four units including two from the 401-404 sequence; first minor, three units with one from the 401-404 sequence; split minor, two units of which one is at 400-level; second minor, two units. A sequence of courses within one area of physiology is desirable for a minor.

Biophysics

The objective of the program in biophysics is to give the student sufficient training in physics, chemistry, and biology to enable him to apply the conceptual, instrumental, and mathematical approaches of the physical scientist to the solution of biological problems. The graduate curriculum is administered by a committee representing both the physical and the biological sciences, with Professor Bernard C. Abbott as chairman. The curriculum is designed for two types of students, those with undergraduate training predominantly in the physical sciences or predominantly in the biological sciences.

Admission requirements are one year of college biology, one year of college physcis, quantitative analysis (five hours), organic chemistry (five hours), and calculus (six hours). However, any deficiencies can be corrected while in training. Applicants must have a grade-point average of at least 4.0.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in biophysics and related subjects. The required courses are Biophysics 401, 402, and two units of additional biophysics courses, a thesis, or special field examination.

For students whose major training has been in the physical sciences, the balance of courses should be selected from the biological science courses; students from the biological sciences select courses from the physical science courses. Candidates for the Master of Science must pass a general examination.

Doctor of Philosophy. A flexible approach is made to curriculum requirements. Students are required, after approximately eight units of graduate study, to pass a qualifying examination, and after sixteen units, to pass a preliminary examination. At some time during the doctoral program, the candidates will be expected to teach for two semesters at half time (or the equivalent). An acceptable course program is given below:

(1) Mathematics, physics, and chemistry: Mathematics 343 or 345; Physics 321, 341, 342, and 381; Chemistry 342, 343, 344 and 345 (a one-year sequence including lectures and laboratory), and Chemistry 350 and 355. Certain of the required physics courses can be waived, upon approval of the committee, in cases where the student has had comparable training in advanced courses in physical chemistry. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is necessary for work in biophysics.

(2) Biology: Zoology 351 or Botany 322; three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. The course in genetics can be included as part of the three-unit requirement in biology.

(3) Biophysics: Biophysics 401 or equivalent; Biophysics 402 and two additional courses in biophysics (other than research).

(4) Minor areas: Students entering from the biological sciences may declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet the approval of the committee.

Minor. Subject to the approval of the committee, candidates for the Doctor of Philosophy in other fields may take a minor in biophysics.

GRADUATE FACULTY

Professors: C. L. Prosser (Head of Department), B. C. Abbott, H. W. Ades, J. D. Anderson, W. R. Ashby, H. S. Ducoff, F. Dunn, R. E. Johnson, A. V. Nalbandov, E. I. Rabinowitch, F. Sargent II, F. R. Steggerda, A. B. Taylor, H. I. Teigler, G. J. Thomas, H. M. Von Foerster.

Associate Professors: D. E. Buetow, J. Gorski, Govindjee, B. A. Hertig, J. R. Larsen, S. G. Stolpe.

Assistant Professors: J. E. Heath, E. S. Kirk, J. S. Willis.

Physiology

COURSES FOR GRADUATES

401. Physiology of Systems and Organs. Analysis of organization and function of vertebrate systems, combining the viewpoints of traditional cellular, comparative, mammalian, and human physiology; nervous, circulatory, digestive, and excretory systems; gross metabolism. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

402. Comparative and Adaptational Physiology. Analysis of mechanisms of adaptation to the environment and to environmental stress, combining the viewpoints of traditional cellular, mammalian, and human physiology, with particular emphasis on the comparative approach. Homeostatic theory, nutrition, osmotic and ionic regulation and cell membranes, respiration and metabolism, temperature relations, bioelectrics, contractile systems. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

403. Cellular and Molecular Physiology. Physicochemical analysis of cellular function and consideration of the implications of the properties of cells for the physiology of multicellular animals. Cell and its organization, cell and the organism, protein structure and specificity, regulation of cell metabolism, cellular basis of hormone action, photobiology. 1 unit. Prerequisite: One year of college-level physics; chemistry including physical and biochemistry; an upper division course in physiology; knowledge of calculus presumed. Staff.

404. Physiological Measurements. Lectures and laboratories concerned with an introduction at a graduate level to current research techniques in the physiological sciences. The laboratories are problem-oriented, and students select four to six special topics, at least one of which must be in each of the following major areas of physiology: (1) nervous system and muscles; (2) mammalian and human; (3) adaptation and radiation biology, and comparative physiology; (4) molecular, cellular, and endocrinological physiology. Within each area there are problems which fall into one or more of the following experimental categories: electrical-mechanical, chemical, and surgical. Selection of problems is done in conjunction with the course secretary so that the student obtains familiarity with techniques in each of these experimental categories and can devote some time to material of consequence relating to his own research interests. Emphasis is placed on the ability to work independently, and students give oral and written reports of their experimentation. 1¼ units. Prerequisite: Chemistry 355 or equivalent, or consent of instructor. Staff.

410. Mammalian Physiology Seminar. Current trends in mammalian physiology. ½ unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. Kirk, Steggerda.

412. **Advanced Endocrinology.** Same as Animal Science, Dairy Science, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. The course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. GORSKI, NALBANDOV.

413. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery, 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

414. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. THOMAS.

421. **Gross Human Anatomy.** A general survey of the structures of the human body with emphasis on the relations between form and function. 1 unit. Prerequisite: One semester of embryology; consent of instructor. STOLPE.

425. **Quantitative Neuroanatomy Lecture.** Same as Electrical Engineering 425. A detailed consideration of (1) quantitative methods of studying structure in the central nervous system, (2) analysis of quantitative data concerning cell and fiber populations and related characteristics in both normal and modified brains, and (3) derivation of neuronal circuitry. 1 unit. Prerequisite: Physiology 416 or equivalent: consent of instructor. ADES, FRY.

426. **Quantitative Neuroanatomy Laboratory.** Same as Electrical Engineering 426. Practice in the use of quantitative methods for precisely determining nerve cell populations and other components of the central nervous system and in measuring properties of subcellular components of anatomic significance. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor. ADES, FRY.

430. **Biological Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. HALL.

431. **Experimental Radiobiology.** Laboratory exercises in irradiation procedures and in the examination of biological responses to ionizing radiations. 1 unit. Prerequisite: Physiology 331 or equivalent; consent of instructor. DUCOFF.

441. **Advanced Comparative Physiology.** Same as Zoology 441. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** Same as Zoology 442. Laboratory experiments presenting comparative principles in osmotic and ionic regulation, respiration and metabolism, temperature regulation of animals, physiology of circulatory systems, of muscle, of sense organs and nervous systems. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441. PROSSER.

451. **Advanced Cellular Physiology.** Same as Zoology 451. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

461. **Fundamentals of Bioclimatology.** Same as Geography 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor. ARMSTRONG, SARGENT.

462. **Experimental Bioclimatology.** Same as Geography 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Physiology 461. ARMSTRONG, SARGENT.

464. **Advanced Human Bioclimatology.** Same as Geography 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Physiology 461. ARMSTRONG, SARGENT.

470. **Human Pathologic Physiology.** Disturbances of function in tissues and organs and their relationship to the pathogenesis of human disease. ¾ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

472. **Human Physiology Seminar.** Topics of current emphasis in human physiology. ½ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

491. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Approval of department. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

Research may be conducted in the following areas, with the consent of the instructor:

(a) **Cellular Physiology and Radiobiology.** ABBOTT, ANDERSON, BUETOW, DUCOFF, PROSSER, TAYLOR.
(b) **Comparative Physiology.** ABBOTT, ANDERSON, HEATH, PROSSER, WILLIS.
(c) **Mammalian Physiology.** NALBANDOV, STEGGERDA.
(d) **Human Anatomy and Human Physiology.** JOHNSON, STOLPE.
(e) **Endocrinology.** GORSKI, NALBANDOV, STOLPE.
(f) **Neurophysiology.** ADES, THOMAS.
(g) **Bioclimatology.** SARGENT.
(h) **Environmental and Stress Physiology.** HERTIG, JOHNSON, SARGENT.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **General Physiology.** Same as Zoology 301. A consideration from the standpoint of experimental biology of functions that are common to most living organisms. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic. ANDERSON, STAFF.

302. **Experimental Animal Physiology.** Same as Zoology 302. Organ physiology of animals with emphasis on homeostasis and physiological interactions of animals with their environment. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic. ANDERSON, STAFF.

304. **Human Factors in Engineering for Space Travel.** Same as Aeronautical and Astronautical Engineering 304. Human factors decisive in the design and operation of manned space vehicles. ½ unit. Prerequisite: Senior or graduate standing in biology, engineering, physical science, or psychology. JOHNSON, STILLWELL.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. ALGER, SILVERMAN.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. ALGER, SILVERMAN.

312. **Endocrinology.** Same as Zoology 312. The glands of internal secretion with special reference to the vertebrates. ¾ unit. Prerequisite: Physiology or Zoology 301, or a course in biochemistry; consent of instructor. GORSKI.

313. **Experimental Endocrinology.** Same as Zoology 313. Laboratory techniques and project in endocrinology. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. GORSKI.

331. **General Radiobiology.** Responses of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. DUCOFF.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Physiology of Physical Activity.** A consideration of the efficiency of physical activity in humans as related to important factors such as training, temperature, altitude, and diet. ¾ unit. Prerequisite: Physiology 103 and 234, or equivalent; one year of chemistry or physics; consent of instructor. JOHNSON, STOLPE.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multi-disciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. LEVINE, STAFF.

Biophysics

COURSES FOR GRADUATES

401. **Advanced Biophysics, I.** Topics given are chosen from applications of the experimental methods of physics to problems of biology, including applications of thermodynamics, material transport (diffusion, barrier layers, and active transport), bioelectricity and irritability, motility, contractility, and momentum transfer. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent, calculus, physical chemistry, or consent of instructor.

402. **Advanced Biophysics, II.** Applications of the experimental and theoretical methods of physics to problems of biology, including the actions of electrical currents, electromagnetic radiations, high energy particles and radiations, and acoustical energy on biological systems; physical phenomena in biological materials, including action currents, photosynthesis, bioluminescence, and others. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry.

403. **Biophysical Techniques.** This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microscopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. ½ or 1 unit. Prerequisite: Credit or registration in Biophysics 402, or consent of instructor. DUNN, MATSUMOTO.

410. **Special Topics in Biophysics.** An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. ½ to 1 unit. Prerequisite: Biophysics 401 or equivalent; Biophysics 402 and 403.

411. **Seminar.** Survey of the literature in one area of biophysics, with special emphasis on student reports. ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor.

435. **Fundamentals of Cybernetics.** Same as Communications 435 and Electrical Engineering 473. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 394 or Mathematics 361, or consent of instructor. ASHBY.

436. **Problems of Cybernetics.** Same as Communications 436 and Electrical Engineering 474. Continuation of Biophysics 435. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Biophysics 435. ASHBY.

463. **Radioisotopes in Biological Research: Principles and Practice.** See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor.

499. **Thesis Research.** Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. 0 to 4 units.
   (a) **Bioacoustics.** DUNN.
   (b) **Electrobiology.** ABBOTT, PROSSER.
   (c) **Information Theory and Cybernetics.** ASHBY, VON FOERSTER.
   (d) **Photosynthesis.** GOVINDJEE, RABINOWITCH.
   (e) **Physics of Muscular Contraction.** ABBOTT, MATSUMOTO.
   (f) **Radiation Biology.** DUCOFF.
   (g) **Cellular Physiology.** BUETOW.
   (h) **Vascular Dynamics.** KIRK.
   (i) **Mechanical Properties of Tissues.** GILMAN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Biophysics.** A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. ¾ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program.

Zoology

The Department of Zoology offers work leading to the Master of Science and Doctor of Philosophy. Five areas of specialization are available: vertebrate zoology; invertebrate zoology; embryology and basic knowledge of cells and tissues; ecology, natural history, and taxonomy; genetics, phylogeny, and evolution.

The grade-point average for admission is 4.0. Applicants with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Applicants should have approximately twenty-five hours of zoology and two semesters each of chemistry, physics, and mathematics. Knowledge of two foreign languages is necessary, and two of the following are recommended: French, German, Russian; Latin and Greek also are helpful.

The Master of Science requires eight units of graduate credit, an acceptable thesis, and, at the end of the program, a successful oral examination. Candidates for this degree who have not had organic chemistry are required to take it, with no graduate credit. Calculus may be recommended.

Admission to advanced standing requires the master's degree or the equivalent and presupposes that the minimum science requirements specified for the master's degree have been met. Any deficiencies must be removed without graduate credit. Additional science requirements for the doctorate include at least one advanced course in physiology and statistics. Quantitative chemistry, biochemistry, and other courses may be recommended by the adviser or doctoral committee. Prior to admission to the oral preliminary examination each applicant must spend a season at an approved marine biological laboratory and pass one formal course primarily concerned with marine invertebrate fauna, and pass the written proficiency examination in any three of the five areas of specialization within the department. The preparation of a satisfactory doctoral thesis and its defense at a final examination are required. It is also required that the results of the thesis investigation be presented at a departmen-

tal or sectional seminar. Further details relating to work in specialized areas in zoology and departmental requirements may be obtained by writing to the head of the department, 345 Natural History Building.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology.

GRADUATE FACULTY

Professors: P. H. Silverman (Head of Department), G. W. Bennett, B. V. Hall, D. F. Hoffmeister, L. Ingle, S. C. Kendeigh, J. B. Kitzmiller, F. J. Kruidenier, A. V. Nalbandov, D. L. Nanney, C. L. Prosser, G. C. Sanderson, H. M. Smith, P. W. Smith, R. L. Watterson.

Associate Professors: R. S. Bader, M. R. Matteson, H. H. Shoemaker.

Assistant Professors: Nelda E. Alger, E. H. Brown, R. Davenport, T. H. Frazzetta, G. L. Freeman, M. R. Lee, E. B. Small, D. C. Sweeney.

COURSES FOR GRADUATES

402. **Molecular Genetics.** See Microbiology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. **Microbiological Genetics.** See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

406. **Physiology of Reproduction.** Same as Animal Science 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. Nalbandov.

407. **Evolutionary Theory.** Genetic, systematic, ecological, and zoogeographical concepts as related to the process of evolution. 1 unit. Prerequisite: One course in genetics or consent of instructor. Bader.

408. **Laboratory Methods in Physiology of Reproduction.** Same as Animal Science 408. ½ to 1 unit. Prerequisite: Consent of instructor. Nalbandov.

411. **Discussions in Genetics and Cytogenetics.** Same as Botany and Microbiology 411. ¼ unit. Bader, Brown, Drake, Kitzmiller, Laughnan, Nanney, Steffensen.

412. **Advanced Endocrinology.** See Physiology 412. Course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. Gorski, Nalbandov.

418. **Advanced Protozoology.** Advanced consideration of selected topics, with emphasis on laboratory practice in modern methods and techniques of studying both free-living and parasitic protozoa: collecting, culturing, and staining of representative forms. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Zoology 318 or equivalent. Small.

419. **Topics in Experimental Protozoology.** Consideration of the advantageous employment of protozoa in modern researches concerned with basic biological problems; selected experimental topics covered by lectures, demonstrations, discussions, reports, and readings. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. Small.

420. **Experimental Invertebrate Zoology.** Study of current research problems and practice in the experimental methods used in the area of invertebrate zoology. 1 unit. Prerequisite: Zoology 320 or equivalent; consent of instructor. Sweeney.

421. **Cytogenetics.** See Botany 421. 1 unit. Prerequisite: Zoology 210, or Microbiology 330, or consent of instructor. Steffensen.

422. **Advanced Parasitology.** Advanced study of modern methods in helminthology. 1 unit. Prerequisite: Zoology 321 or equivalent. Kruidenier.

423. **Electron Microscopy.** See Biology 423. ¼ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; consent of instructor. HALL.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Zoology 304. MATTESON.

425. **Experimental Parasitology.** Same as Veterinary Medical Science 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. ANDERSON, LEVINE, SILVERMAN.

429. **Electron Microscopy Laboratory.** See Biology 429. ½ or ¾ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; credit or registration in Zoology 423; consent of instructor. HALL, PAGE.

430. **Biological Ultrastructure.** Same as Entomology, Microbiology, and Physiology 430. Lectures and reports on the fine structure of plant and animal cells and cell products with discussions of possible relationships of ultrastructure to function and of diverse interpretations of chemical-physical information as ultrastructure. 1 unit. Prerequisite: Consent of instructor. HALL.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. May be elected in successive years. ½ unit. Maximum credit for master's candidates, one unit; for doctoral candidates, three units. Prerequisite: Zoology 333 and 367. WATTERSON.

441. **Advanced Comparative Physiology.** See Physiology 441. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** See Physiology 442. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441.

444. **Concepts in Ethology.** Group discussion of problems such as stimulus filtering, spontaneity, and stereotyped motor patterns, with a new topic each semester. ½ unit. Prerequisite: Zoology 346.

445. **Advanced Ecology and Wildlife Management.** Seminar on modern techniques, concepts, and problems. ½ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Zoology 345 or equivalent. KENDEIGH.

446. **Physiological Ecology.** Physiological adjustments and responses of organisms to their environment. 1 unit. KENDEIGH.

451. **Advanced Cellular Physiology.** See Physiology 451. ½ unit. Prerequisite: Consent of instructor. STAFF.

467. **Experimental Embryology.** 1 unit. Prerequisite: Zoology 367. WATTERSON.

499. **Thesis Research.** 0 to 4 units. Work in the following fields is offered for students registered in Zoology 499:

Anatomy, Physiology, and General Classification of Vertebrates: Vertebrate Anatomy, BADER, SMITH; Endocrinology, HALL, NALBANDOV; Functional Anatomy, FRAZZETTA; Histology, DAVENPORT; Ultrastructure, HALL; Vertebrate Physiology, PROSSER.

Anatomy, Physiology, and General Classification of Invertebrates: Helminthology, KRUIDENIER, SILVERMAN; Invertebrate Zoology, MATTESON, SWEENEY; Invertebrate Physiology, ALGER, KRUIDENIER, PROSSER, SILVERMAN, SWEENEY; Protozoology, SMALL.

Embryology and Basic Knowledge of Cells and Tissues: Cytology, DAVENPORT; Embryology and Regeneration, DAVENPORT, FREEMAN, WATTERSON; Toxicology, INGLE.

Principles of Ecology, Principles of Taxonomy, Natural History: Ecology, KENDEIGH; Ethology, BANKS; Herpetology, H. SMITH; Ichthyology, SHOEMAKER,

P. Smith; Limnology, Bennett, Matteson; Mammalogy, Hoffmeister, Lee; Ornithology, Kendeigh; Wildlife Management, Kendeigh, Sanderson, Shoemaker.
Genetics, Phylogeny, Evolution: Genetics and Evolution, Brown, Kitzmiller, Nanney; Vertebrate Phylogeny and Paleontology, Bader, Frazzetta.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students, but also open to seniors whose major is zoology. No credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Parasitology-Protozoology Seminar.

301. **General Physiology.** See Physiology 301. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic.

302. **Experimental Animal Physiology.** See Physiology 302. 1 unit. Prerequisite: One year each of college-level biology, mathematics, and physics; chemistry through organic.

303. **Individual Topics.** For those who wish to study individual problems. Graduate students may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. ½ or 1 unit. Prerequisite: Two years of zoology; consent of department. Staff.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and land and fresh-water invertebrates; habits and life histories of selected forms. 1 unit. Prerequisite: One year of zoology or equivalent; consent of instructor. Matteson.

305. **Principles of Systematic Zoology.** Theory and practice in proper procedure for formation and for determination of status names for classification of animal populations. ½ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. H. Smith.

306. **Biology for Teachers.** See Botany 306. ½ unit. Prerequisite: Botany 100 and Zoology 104, or a year course in general biology.

307. **Immunobiology.** Same as Botany, Entomology, Microbiology, and Physiology 307. A survey of immune responses of vertebrates and invertebrates; the immunological relationships of protozoan and helminth parasites to their hosts; the influence of immune phenomena on development and evolution. Lecture. ½ unit. Prerequisite: One year of biological science; organic chemistry; or consent of instructor. Alger, Silverman.

308. **Experimental Immunobiology.** Same as Botany, Entomology, Microbiology, and Physiology 308. An introduction to laboratory techniques employed in the immunological investigations. Laboratory. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. Alger, Silverman.

312. **Endocrinology.** See Physiology 312. ¾ unit. Prerequisite: Zoology 301 or a course in biochemistry; consent of instructor. Gorski.

313. **Experimental Endocrinology.** See Physiology 313. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. Gorski.

318. **Protozoology.** Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. 1 unit. Prerequisite: One year of zoology or equivalent. Small.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. 1 unit. Prerequisite: Biology 110, 111, or Zoology 104. Sweeney.

321. **Parasitology.** Warm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. 1 unit. Prerequisite: One year of zoology or equivalent. KRUIDENIER.

324. **Vertebrate Paleontology.** Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Zoology 132 or Geology 102. BADER.

330. **Practical Microtechnique.** An introduction to microscopy, microphotography, and histological technique. ½ unit. Prerequisite: Histology or embryology and consent of instructor. ALGER, KRUIDENIER.

331. **Experimental Cytology.** See Botany 331. 1 unit. Prerequisite: Botany or Zoology 210 or Biology 151 and 251; consent of instructor; biochemistry is recommended. DAVENPORT, STEFFENSEN.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology; comparative anatomy, evolution, and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. 1 unit. Prerequisite: Zoology 132. FRAZZETTA.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. 1 unit. Prerequisite: Zoology 132. WATTERSON.

334. **Vertebrate Histology and Cytology.** Microscopic study of the cell, tissues, organs, and organ systems of the vertebrate body. 1 unit. Prerequisite: One year of zoology or equivalent. DAVENPORT.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. ½ unit. Prerequisite: Biology 110, 111, or Zoology 104. WILLSON.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. 1 unit. Prerequisite: Zoology 132. HOFFMEISTER, LEE.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. ½ unit. Prerequisite: Zoology 132. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. ½ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Zoology 132. H. SMITH.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111; consent of instructor. WILLSON.

341. **Field Ecology.** During spring vacation, study of biotic communities, mammals, birds, reptiles, amphibia, fishes, and invertebrates in various sections of North America. Outdoor camping and cooking. Transportation in University cars. ¼ unit. Prerequisite: Credit or registration in one of the following: Zoology 304, 335, 336, 337, 338, 340, 345; consent of instructor. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. ½ unit. Prerequisite: Biology 110, 111, or Zoology 104. SHOEMAKER.

343. **Limnology.** Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. 1 unit. Prerequisite: Biology 110, 111, or Zoology 104, or Botany 100. MATTESON.

345. **Animal Ecology.** Composition, dynamic development, and distribution of biotic communities. ¾ or 1 unit. Students enrolling for three-fourths unit are required to do field work on eight Saturdays; those enrolling for one unit are required to do field or laboratory work every Saturday, including one weekend camping trip; estimated expense, $8.50. Prerequisite: One year of zoology and/or entomology, or consent of instructor; for students enrolling for three-fourths unit, concurrent registration in Zoology 342. KENDEIGH.

346. **Ethology.** The behavior of animals as interpreted through comparative studies and experimentation. Laboratory consists of observation, experiments, occasional field trips, and an individual term project. Lecture, ½ unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratory enrollment.

367. **Analysis of Development.** Advanced study of basic problems in developmental biology. Major emphasis is placed on interactions at molecular, fine structural, and cellular levels and the genetic and metabolic mechanisms by which these interactions are controlled in plants and animals. Theories of differentiation are critically examined in the light of recent research. Lectures, discussions, outside readings, and student reports. 1 unit. Prerequisite: One course in each of the following areas: embryology, genetics, either cytology or histology, calculus, and organic chemistry; or equivalent. FREEMAN.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology, KENDEIGH, SHIMKIN, STAFF.

375. **Population and Community Ecology.** Exposition of the populational viewpoint in animal ecology. Starting with the basic properties of populations, the discussion explores the growth and regulation of single-species populations, interactions between populations of different species, and properties of natural communities and interrelationships between ecological and evolutionary phenomena. ¾ unit. Prerequisite: Zoology 345 or equivalent; college algebra.

LINGUISTICS

(Including Arabic, Burmese, Chinese, Hindi, Indonesian, and Japanese)

The Department of Linguistics offers a graduate program leading to the Master of Arts and Doctor of Philosophy. The following fields of linguistics are available for concentration: descriptive linguistics, historical linguistics, interdisciplinary study in psycholinguistics, ethnolinguistics, experimental phonetics, and mathematical linguistics.

Undergraduate preparation for the study of linguistics should include the equivalent of at least three years of foreign language experience; for historical linguistics, a broad background in the humanities and social studies; and for descriptive linguistics, the equivalent of good undergraduate training in mathematics and the sciences. Students applying for admission must have at least a 3.75 grade-point average for that portion of the work which represents the last sixty hours earned towards the bachelor's degree.

Master of Arts. Candidates for this degree must earn eight units, of which six units must be in linguistics. At least two of the required units in linguistics must be chosen from 400-level courses and must include Linguistics 401, Linguistic Analysis, I.

In addition to fulfilling the general requirements of the Graduate College and passing the comprehensive qualifying examination in general linguistics (and special

subjects, if appropriate), the student also must pass the reading examination in one foreign language and must submit a satisfactory master's essay to the department.

Doctor of Philosophy. Candidates for this degree must complete at least twenty-four units of graduate work, or sixteen units beyond the master's degree. Eight of the minimum twenty-four units must be in Linguistics 499, Thesis Research. Students of descriptive linguistics must attain a grade of B or better in Linguistics 401, Linguistic Analysis, I, and Linguistics 402, Linguistic Analysis, II.

Students are encouraged to attend at least one summer session of the Linguistic Institute of the Linguistic Society of America. Up to four units of credit granted by the host university under this program may be transferred. Students of descriptive linguistics also are strongly urged to establish a vested interest and a firm basic foundation in some particular language or language family at as early a point as possible in their graduate career.

Candidates must fulfill the language requirements of the Graduate College and must pass the comprehensive qualifying examination (mentioned above for the master's degree), preferably after the first year of graduate work, unless they have already qualified for the Master of Arts in Linguistics.

Linguistically oriented courses in related departments may be counted towards the major if approved by the adviser. The head of the department acts as general adviser to each student until he selects his field of concentration, at which time he comes under the guidance of an adviser in his special area.

GRADUATE FACULTY

Professors: R. B. Lees (Head of Department), J. H. D. Allen, J. B. Casagrande, H. R. Kahane, L. R. Micklesen, M. A. Morínigo, C. E. Osgood, A. Tovar.

Associate Professors: Katherine O. Aston, F. K. Lehman, H. S. Maclay.

Assistant Professors: B. B. Kachru, T. M. Lightner, J. Yegerlehner, W. R. Zemlin, A. M. Zwicky.

Instructor: C. C. Cheng.

Linguistics

COURSES FOR GRADUATES

401. **Linguistic Analysis, I: Syntax.** Motivations for syntactic analysis; linguistic theories; critique of constituent-structure theories; introduction to mathematical linguistics; theory of transformational grammars; semantic theories of sentencehood. 1 unit. Prerequisite: Linguistics 300 or equivalent. Zwicky.

402. **Linguistic Analysis, II: Phonology.** Morphophonemic analysis of sentences; critique of taxonomic phonemics; distinctive-feature theory; analysis of stress in English. 1 unit. Prerequisite: Linguistics 401 or equivalent. Lightner.

403. **Seminar in Linguistic Analysis.** Discussion of advanced topics of current interest in descriptive linguistics. 1 unit. Prerequisite: Linguistics 401. Zwicky.

404. **Linguistic Analysis, III: Practicum.** Classroom- and homework-solving of assorted problems in syntactic and phonological analysis of many languages. ½ unit. Prerequisite: Linguistics 401 and 402.

405. **Mathematical Linguistics.** Study of formal systems and generative capacity of grammars; finite-state and phrase-structure models; hierarchy or generative models; review of statistical characterization of texts. 1 unit. Prerequisite: Linguistics 401, Mathematics 118, or equivalent. Zwicky.

411. **Methods in Historical Linguistics.** Advanced analysis of genetic comparison and reconstruction, linguistic borrowing, linguistic geography, etymology, and related topics. 1 unit. Prerequisite: Linguistics 302 or 315. Kahane.

412. **Research Seminar in Historical Linguistics.** Research work in etymology, linguistic geography, and historical syntax. 1 unit. Prerequisite: Linguistics 411 or consent of instructor. KAHANE.

415. **Seminar in Indo-European Linguistics.** Discussion and research paper on topics in Indo-European languages, their history, origins, development, and migration. 1 unit. TOVAR.

424. **Linguistics and Communication.** Same as Communications 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. MACLAY.

425. **Psycholinguistics.** Same as Communications and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Communications and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. ½ or 1 unit. Prerequisite: Linguistics 425; consent of instructor. MACLAY, OSGOOD.

450. **Seminar in Ethnolinguistics.** Consideration of selected problems relating linguistic structure and language behavior to other aspects of culture. 1 unit. Prerequisite: Linguistics 370 or consent of instructor. YEGERLEHNER.

462. **Introduction to Romance Linguistics.** Same as French, Spanish, Italian, and Portuguese 462. Comparative and historical analysis of the Romance languages. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

473. **Seminar in Phonetics.** Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

475. **Experimental Phonetics, I.** Same as Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. **Experimental Phonetics, II.** Same as Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. **Measurement of Speech, I.** Same as Speech 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Lingistics 475. ZEMLIN.

478. **Measurement of Speech, II.** Same as Speech 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 476. ZEMLIN.

490. **Special Topics in Linguistics.** Individual studies in the areas of linguistics not covered by regular course offerings. ½ to 2 units.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** An introduction to the science of descriptive linguistics. ½ or 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

301. **General Phonetics.** Same as Speech 301. Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit.

302. **Comparative Linguistics.** An introduction to the historical aspects of language. ½ or 1 unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

303. **Non-Western Linguistic Structures.** Intensive study of linguistic structure of a selected non-Western language. ¾ unit.

305. **Introduction to Applied Linguistics.** An introduction to the applications of general linguistic theory to the specific fields of stylistics, theory of translation, contrastive analyses, and the teaching and learning of foreign (and second) languages. Practical assignment work. ¾ unit. Prerequisite: Consent of instructor. KACHRU.

309. **Field Methods in Linguistics.** Same as Anthropology 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. LEHMAN, YEGERLEHNER.

310. **Advanced Field Methods in Linguistics.** Same as Anthropology 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 309 or equivalent. LEHMAN, YEGERLEHNER.

315. **Introduction to Indo-European Linguistics.** An introduction to the formation and spread of languages in the early stages of Indo-European civilization; methods of reconstruction and comparison. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences. TOVAR.

317. **Languages of the World.** Same as Anthropology 317. A survey of the main language families of the world from both genetic and typological points of view. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

318. **Linguistic Types.** A technical sketch of syntactic and phonological structure of four or more divergent, non-Indo-European languages. 1 unit. Prerequisite: Linguistics 300 or 317.

325. **Introduction to Psycholinguistics.** Same as Communications 325. An introductory survey of psychological and linguistic approaches to the study of communication. ½ or 1 unit. Prerequisite: An introductory course in linguistics or psychology. MACLAY.

338. **Philosophies of Language.** Same as Philosophy 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

350. **Sociolinguistics.** A critical study of the sociologically oriented general linguistic theories with special reference to language varieties, language attitudes, language diversity, language standardization, linguistics geography, language and political roles (language loyalty). Emphasis on research methodology and techniques. Concentration on South Asia. ½ unit. Prerequisite: Linguistics 300 or consent of instructor. KACHRU.

351. **Area Linguistics.** Introduction to area classification, linguistic convergence, and borrowing; the Southeast Asia *Sprachbund;* phonological, morphological, and syntactic convergence. 1 unit. Prerequisite: Linguistics 300.

370. **Language, Culture, and Society.** Same as Anthropology and Communications 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

375. **Speech Science.** Same as Speech 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Linguistics 301 or consent of instructor. ZEMLIN.

376. **Speech Science.** Same as Speech 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Linguistics 375 or consent of instructor. ZEMLIN.

380. **Introduction to Slavic Linguistics.** Same as Russian 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit. MICKLESEN.

387. **The Structure of English.** Same as English 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit. LEES.

388. **Linguistics in Language Learning, I.** Same as Rhetoric 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language, or equivalent; consent of instructor. ASTON.

389. **Linguistics in Language Learning, II.** Same as Rhetoric 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Linguistics 388. ASTON.

Arabic

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Arabic, I.** First term of second year of work in the Arabic language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Arabic 202 or equivalent. ABDO.

304. **Intermediate Arabic, II.** Concentration upon ability to engage in reasonably fluent discourse in Arabic, on comprehensive knowledge of formal grammar, and on ability to read ordinary written Arabic. ½ unit. Prerequisite: Arabic 303 or equivalent. ABDO.

Burmese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Burmese, I.** Introduction to a wider variety of styles and contexts of discourse and usage. Written Burmese and an orderly view of Burmese grammar. ½ unit. Prerequisite: Burmese 202 or equivalent. LEHMAN.

304. **Intermediate Burmese, II.** Concentration upon ability to engage in active and reasonably fluent discourse in Burmese, on the grammar of sentence formation and ability to read ordinary Burmese texts. ½ unit. Prerequisite: Burmese 303 or equivalent. LEHMAN.

Chinese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Chinese, I.** First term of second year of work in the Chinese language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Chinese 202 or equivalent. CHENG.

304. **Intermediate Chinese, II.** Concentration upon ability to engage in fluent discourse in Chinese, on comprehensive grammatical knowledge, and on ability to read any ordinary simple text in Chinese. ½ unit. Prerequisite: Chinese 303 or equivalent. CHENG.

Hindi

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Hindi, I.** First term of second year of work in the Hindi language, with drill for more advanced conversational fluency; introduction of a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Hindi 202 or equivalent.

304. **Intermediate Hindi, II.** Concentration upon ability to engage in reasonably fluent discourse in Hindi, on comprehensive knowledge of formal grammar, and on ability to read ordinary texts in Hindi. ½ unit. Prerequisite: Hindi 303 or equivalent.

Indonesian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Indonesian, I.** First term of second year of work in the Indonesian language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Indonesian 202 or equivalent. YERGERLEHNER.

304. **Intermediate Indonesian, II.** Concentration upon ability to engage in reasonably fluent discourse in Indonesian, on comprehensive knowledge of grammar, and on ability to read ordinary written Indonesian. ½ unit. Prerequisite: Indonesian 303 or equivalent. YERGERLEHNER.

Japanese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Japanese, I.** First term of second year of work in the Japanese language, with drill for increased conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Japanese 202 or equivalent. MAKINO.

304. **Intermediate Japanese, II.** Concentration upon ability to engage in reasonably fluent discourse in Japanese, on comprehensive view of formal grammar, and on ability to read simple written Japanese. ½ unit. Prerequisite: Japanese 303 or equivalent. MAKINO.

MARKETING

Graduate work may be taken in the field of marketing for a major or a minor for the Master of Science and for the Doctor of Philosophy. To do major work in this field, a student must have a grade-point average of at least 4.0 and adequate training in quantitative analysis and the social sciences.

GRADUATE FACULTY

Professors: R. Ferber, R. M. Hill, F. M. Jones, R. V. Mitchell, H. G. Wales.

Associate Professors: D. M. Slate (Head of Department), L. M. DeBoer, R. D. Millican.

COURSES FOR GRADUATES

401. **Marketing Principles and Problems.** Functional, commodity, and institutional methods of studying marketing with particular reference to the analysis and classifications of functions, commodities, and institutions. 1 unit.

402. **Marketing Methods and Problems.** Selected problems in the operation and management of market institutions. 1 unit.

407. **Prices and Price Policies.** An examination of the role of prices in our economy; of pricemaking under conditions of competition, monopoly, or monopolistic competition, with special emphasis on nonprice competition; an examination of business pricing policies and of their acquisitive and social implications and significance. 1 unit.

415. **Merchandising Trends and Problems.** The literature, trends, policies, and organization problems involved in retail merchandising. 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor.

416. **Merchandising Policies and Problems.** The policies and problems relating to merchandise control, personnel, publicity, and promotion; recent literature and legislation. 1 unit. Prerequisite: Marketing 101 or equivalent; consent of instructor.

421. **Analysis of Consumer Markets.** A study of consumers and their demands. 1 unit.

422. **Advanced Marketing Research.** Advanced marketing research theory, literature, objectives, techniques, and problems of marketing research. 1 unit. Prerequisite: Marketing 321 or consent of instructor.

471. **The Development of Marketing.** The development of marketing organizations, problems, and methods in the United States from colonial times to the present; wholesaling, retailing, market growth, consumer buying habits, advertising, selling, pricing, legislation, trade channels. 1 unit. Prerequisite: Marketing 101 or consent of instructor.

472. **Sales Campaigns.** Problems in managing the sales force. 1 unit.

493. **Research in Special Fields.** ¼ to 2 units.

499. **Thesis Research.** Thesis or independent study in the field of marketing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: Marketing majors do not receive graduate credit for courses in the 300 series.

320. **Marketing Research.** An investigation of the development and applicability of information systems techniques to marketing problems. The marketing management process is analyzed; the underlying concepts related to the information needed to serve the processes are explored; and the incorporation of information resources into the management function is demonstrated. This course covers the use of behavioral sciences research methods, social processes and structure influences upon marketing activities, demographic variables, application of Baye-

sian decision theory, studies of promotional activity, simulation and programming models, planning models, and strategy formulation models which provide an analytical structure for the solution of marketing problems. ½ unit. Prerequisite: Marketing 201.

337. **Advertising and Sales Management.** Designed to enable the student, through directed and supervised investigation of selected psychological, economic, and sociological problems, to become acquainted with the methods of demand analysis and its application to the interrelationships of marketing management, advertising management, and sales management. Discussion of communication theory as it relates to the goals and means of winning patronage for the firm. Emphasis is on the effect, or control, of the communication process. Class discussion is focused upon literature in demand stimulation and communications and the testing of relevant hypotheses. ½ unit. Prerequisite: Marketing 201.

344. **Consumer Market Behavior.** An analysis of consumer motivation, buying behavior, market adjustment, and product innovation, including a survey of explanatory theories of consumer market behavior and producer reactions. This course covers behavioral aspects of the marketing process from the producer to ultimate user, or consumer. Fundamentals of product planning, development, engineering, and promotion are viewed as part of the total marketing program. Normative models of the decision-making process for winning patronage in intermediate, industrial, and consumer markets are considered. The decision-making process by consumers is evaluated with reference to psychological drives used by producers, middlemen, and consumers. ½ unit. Prerequisite: Marketing 201.

352. **Pricing Policies.** The essential nature of marketing decisions and pricing, marketing organization and the pricing process, price theories and pricing models; contributions of operations research and behavioral sciences to pricing analysis; the relationship of pricing objectives, methods, strategies, and policies to market behavior and the goals of the firm. ½ unit. Prerequisite: Marketing 201.

360. **Marketing Logistics.** The ecology, analysis, and development of integrated distribution systems; the application of quantitative tools, economic analysis, transportation and marketing management in the analysis, and interpretation and design of the physical flow of goods through marketing network alternatives. Attention is given to the theory of market structures, transport networks, location, and cost control. Consideration is also given to site selection, warehousing, inventory management, logistic communications networks, and data control models. ½ unit. Prerequisite: Marketing 201.

370. **International Marketing.** The role of enterprise, comparative marketing, and transport institutions and systems, and comparative marketing organizations and systems of administration in selected foreign countries and the United States; the managerial and operational problems of world enterprise, with emphasis on the role of ethnic and cultural differences in influencing marketing strategy. ½ unit. Prerequisite: Marketing 201; consent of instructor.

380. **Advanced Marketing Management.** The appraisal and diagnosis, organization and planning, action and control of commodity and product-service distribution, marketing analysis and systems, and demand stimulation; a survey of normative models for decision-making in a variety of marketing situations and systems; introduction to the behavioral theory of the firm and its application to different marketing targets, institutional settings, or market arrangements; discussion of the various analytical tools available to firms for appraising, diagnosing, organizing, planning, and formulating market strategies. Principles of behavioral sciences and quantitative techniques are emphasized. A terminal course that integrates the analysis of a wide range of marketing problems and situations. ½ unit. Prerequisite: Marketing 320 and 337.

Note: See also Business Administration 373, Electronic Data Processing for Business.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the Master of Arts or Master of Science in Mathematics and Doctor of Philosophy in Mathematics, Master of Science in the Teaching of Mathematics, and Master of Arts or Master of Science in Statistics and Doctor of Philosophy in Statistics. For information concerning applied mathematics, see page 253.

MATHEMATICS

For admission a beginning graduate student must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

A student should have had twenty-three hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and at least nine semester hours of more advanced work in one or more of the fields of algebra, geometry, topology, analysis, and number theory. The last requirement refers to courses equivalent to Mathematics 317-318, 327-328, 332-333, 347-348, 353-354, and 387.

Master of Arts or Master of Science in Mathematics. The departmental requirements for the master's degree in mathematics are as follows: of the eight units required for the degree, at least six must be in mathematics, at least three of them in approved 400-level courses. Mathematics 347-348 and at least one other basic year sequence at or above the intermediate level, normally one of the sequences 317-318, 327-328, 332-333, should be included. More than one-half of this last requirement should be fulfilled in previous undergraduate work, A master's thesis is not required.

Master of Science in the Teaching of Mathematics. Candidates for the Master of Science in the Teaching of Mathematics must earn four units in mathematics, two units in education, and two units in electives. Requirements are two units from Mathematics 307 and 347; History and Philosophy of Education 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor Wilson M. Zaring, 303 Altgeld Hall.

Doctor of Philosophy in Mathematics. The departmental requirements for the Doctor of Philosophy are as follows: of the sixteen units of course work required before the preliminary examination, eight must be in mathematics courses at the 400 level for students with a full outside minor, and ten must be in mathematics courses at the 400 level for students with one internal minor. Majors and minors within the department are chosen from the following six fields: analysis (including linear spaces, theory of probability, and analytic number theory), algebra (including group theory and mathematical logic), geometry, topology, statistics, and applied mathematics. At least two courses at the 400 level are required for an internal minor. The language requirement may be met in any two of three languages, French, German, and Russian. The Graduate College requirements concerning residence, oral examination, research units after the oral examination, thesis, and final examination must be satisfied.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor

for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology. The program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee.

For admission to full standing, a beginning graduate student must have a grade-point average of not less than 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is helpful. Students are admitted on limited status.

Master of Arts or Master of Science in Statistics. A candidate for the master's degree in statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 37 to 44), he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

Doctor of Philosophy in Statistics. The thesis for the Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics and one representing mathematics or a field of application.

A candidate for the Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315, 347, or equivalent; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Department of Mathematics and including all courses in statistics listed jointly by the Department of Mathematics and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

Candidates for a Doctor of Philosophy taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

GRADUATE FACULTY

Professors: P. T. Bateman (Head of Department), R. G. Bartle, C. R. Blyth, W. W. Boone, D. L. Burkholder, S. S. Cairns, M. M. Day, J. L. Doob, D. B. Gillies, S. I. Goldberg, W. Haken, M. H. Heins, A. Heller, F. E. Hohn, P. W. Ketchum, R. G. Langebartel. H. Levy, C. W. Mendel, H. J. Miles, D. E. Muller, H. Osborn, R. E. Pingry, I. Reiner, L. A. Rubel, H. H. Schaefer, E. J. Scott, M. Suzuki, W. J. Trjitzinsky, C. Ionescu Tulcea, H. E. Vaughan, R. A. Wijsman.

Associate Professors: R. B. Ash, R. L. Bishop, R. E. Block, R. W. Carroll, Josephine H. Chanler, W. A. Ferguson, J. W. Gray, N. T. Hamilton, Mary-Elizabeth Hamstrom, L. L. Helms, R. P. Jerrard, B. H. McCormick, E. T. Parker, J. W. Peters, W. J. Poppelbaum, J. J.

ROTMAN, JEWELL E. SCHUBERT, G. TAKEUTI, ALEXANDRA IONESCU TULCEA, J. H. WALTER, W. M. ZARING.

Assistant Professors: O. G. ABERTH, K. I. APPEL, J. W. ARMSTRONG, FELICE D. BATEMAN, GENEVA G. BELFORD, I. D. BERG, G. R. BLAKLEY, J. A. EAGON, D. J. EUSTICE, C. W. GEAR, F. B. KNIGHT, R. E. LEWKOWICZ, CHIN-PI LU, L. R. MCCULLOH, T. G. MCLAUGHLIN, G. A. METZE, PATRICIA T. MONTAGUE, IRMA M. REINER, N. J. ROTHMAN, D. R. SHERBERT, P. M. WEICHSEL, E. C. WEINBERG, J. E. WETZEL.

Instructors: J. R. ALEXANDER, JR., S. B. BANK, C. E. LINDERHOLM, K. WITZ.

COURSES FOR GRADUATES

401. **Second Course in Abstract Algebra, I.** The Noether isomorphism theorem for groups; permutation groups; simplicity of the alternating group; Jordan-Holder theorem; Euclidean rings; fundamental theorem of Galois theory. 1 unit. Prerequisite: Mathematics 317 and 318.

402. **Second Course in Abstract Algebra, II.** Wedderburn theorem on semi-simple rings; fundamental theorem of finitely generated Abelian groups (with application to canonical forms for matrices); Krull-Schmidt theorem; tensor products; exterior algebra. 1 unit. Prerequisite: Mathematics 401.

403. **Theory of Rings.** Ideal theory in commutative rings; structure of noncommutative rings. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

404. **Group Theory.** Structure of groups, derived groups, nilpotence and solvability, extensions and products. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

405. **Theory of Fields.** Further development of the theory of fields covering topics from valuation theory, ideal theory, units in algebraic number fields, ramification, function fields, local class field theory. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

406. **Homological Algebra.** An axiomatic treatment of the algebraic systems basic in topology. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

407. **Group Representation Theory.** Representation of groups by linear transformations, group algebras, character theory, modular representations. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

408. **Lie Groups.** 1 unit. Prerequisite: Mathematics 332, 404, and 441.

414. **Logical Foundations of Mathematics.** A discussion of the logical and philosophical foundations of mathematics. 1 unit. Prerequisite: Philosophy 333, or Mathematics 317 or 347, or consent of instructor.

415. **Advanced Topics in the Theory of Groups.** 1 unit. Prerequisite: Consent of instructor.

416. **Advanced Topics in Abstract Algebra.** 1 unit. Prerequisite: Consent of instructor.

420. **Projective Geometry.** 1 unit. Prerequisite: Mathematics 328.

422. **Algebraic Geometry.** 1 unit. Prerequisite: Mathematics 328.

423. **Differential Geometry.** 1 unit. Prerequisite: Mathematics 343.

424. **Riemannian Geometry.** Local and global properties of Riemannian manifolds. 1 unit. Prerequisite: Mathematics 423.

425. **Differentiable Manifolds, I.** Foundations of modern differential geometry, including multilinear algebra, exterior calculus, Stokes' theorem, Frebenius' theorem, affine connections, elements of Riemannian geometry and Lie groups, sheaves, cohomology of manifolds, the DeRham theorem, differentiable fiber bundles, the holonomy theorem, the Hodge theorem, elements of complex analytic manifolds. 1 unit. Prerequisite: Mathematics 318 and 332.

426. **Differentiable Manifolds, II.** See Mathematics 425 for description. 1 unit. Prerequisite: Mathematics 425.

428. **Topics in Geometry.** 1 unit. Prerequisite: Consent of instructor.

430. **Elementary Geometry from a Modern Viewpoint.** Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. **Algebraic Topology, I.** Continuation of Mathematics 333. Categories and functors, homotopy groups, singular homology, Kunneth theorem, products in cohomology. 1 unit. Prerequisite: Mathematics 333.

432. **Algebraic Topology, II.** Continuation of Mathematics 431. CW-complexes, Cech homology, duality, spectral sequences, and other topics. 1 unit. Prerequisite: Mathematics 431.

433. **Fibre Spaces.** 1 unit. Prerequisite: Consent of instructor.

434. **Combinatorial and Differential Topology.** 1 unit. Prerequisite: Consent of instructor.

435. **General Topology.** Separation; global and local compactness and connectedness; compactification and completion; function spaces; other topics. 1 unit. Prerequisite: Mathematics 332 or consent of instructor.

438. **Topics in Topology.** 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** 1 unit. Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** Application of the elementary theory is made to the study of conformal mappings, Riemann surfaces, entire and meromorphic functions. 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. **Real Analysis, I.** Lebesgue measure on the real line, integration and differentiation of real functions, elementary applications to harmonic analysis. 1 unit. Prerequisite: Mathematics 347 or equivalent.

442. **Real Analysis, II.** Metric spaces, introduction to functional analysis, integration on general measure spaces. 1 unit. Prerequisite: Mathematics 441.

443. **Ordinary Differential Equations.** Existence, uniqueness, and continuation of solutions; topics selected from: the theory of linear differential operators, Sturm-Liouville theory, stability theory, qualitative theory of differential equations. 1 unit. Prerequisite: Mathematics 347 and a first course in ordinary differential equations.

444. **Partial Differential Equations.** 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable, II.** 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** Geometrical properties of Hilbert spaces; linear operators; the spectral theory for self adjoint and related operators. 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** Geometrical properties of Banach spaces; bounded linear operators; applications to analysis; linear topological spaces. 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** Properties of normed rings; representation as rings of continuous functions or rings of bounded operators; applications to spectral theory, harmonic analysis, etc. 1 unit. Prerequisite: Mathematics 318 and 446 or 447.

451. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 455.

457. **Advanced Numerical Analysis.** Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequisite: Mathematics 387 or consent of instructor.

458. **Numerical Solution of Partial Differential Equations.** The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by iterative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Mathematics 455 or consent of instructor.

459. **Topics in Hydrodynamics.** 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

461. **Applied Stochastic Processes.** Introduction to topics such as spectral analysis, filtering theory, and prediction theory of stationary processes, Markov chains and Markov processes. 1 unit. Prerequisite: Mathematics 346 and 347.

463. **Information Theory.** Same as Electrical Engineering 463. Mathematical models for information channels and sources: existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361.

465. **Topics in Automata Theory.** Same as Electrical Engineering 465. 1 unit Prerequisite: Mathematics or Electrical Engineering 392, or consent of instructor.

468. **Topics in Analysis.** 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision-making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to nonsequential and sequential decision-making in practice. 1 unit. Prerequisite: Consent of instructor.

472. **Econometrics.** Same as Economics 472. Point estimates of parameters for systems of simultaneous equations; properties of various estimators; hypothesis testing and confidence intervals for econometric models. 1 unit. Prerequisite: Mathematics 363 and 315, or consent of instructor.

473. **The Theory of Testing Hypotheses.** Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. 1 unit. Prerequisite: Consent of instructor.

474. **The Theory of Estimation.** Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. 1 unit. Prerequisite: Consent of instructor.

478. **Topics in Statistics.** 1 unit. Prerequisite: Consent of instructor.

487. **Theory of Approximation.** General approximation theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

488. **Topics in Applied Mathematics.** 1 unit. Prerequisite: Consent of instructor.

489. **Seminar in Applied Mathematics.** 1 unit. Prerequisite: Consent of instructor.

490. **Reading Course.** 1 to 2 units. Prerequisite: Consent of instructor.

493. **Proseminar.** An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. 1 unit. Prerequisite: Mathematics 347; credit or registration in Mathematics 348.

499. **Thesis Research.** 0 to 4 units. Prerequisite: Consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Theory of Sets and the Real Number System.** This course deals with elementary naive set theory and the development of the integers, the rational numbers, and the real numbers; principal emphasis is upon the mathematical needs of the secondary teacher. 1 unit. Prerequisite: One year of calculus or consent of instructor.

301. **Fundamental Concepts of Algebra.** 1 unit. Prerequisite: One year of calculus or consent of instructor.

302. **Topics in Geometry.** Historical development of geometry, including tacit assumptions made by Euclid, Euclid's Fifth Postulate and its equivalents, and the discovery of non-Euclidean geometries; geometry as a mathematical structure; finite geometries; geometry as a study of invariants of set transformations; projective geometry; applications of group theory to geometry; vector geometry. 1 unit. Prerequisite: One year of calculus or consent of instructor.

303. **Advanced Aspects of Euclidean Geometry.** Selected topics from geometry as for example, circumcircle, nine-point circle, theorem on centroid and orthocenter, the construction of regular figures, isometries in the plane and space, rotations and translations, fixed points, ordered and affine geometries, geometry of inversive plane. 1 unit. Prerequisite: One year of calculus or consent of instructor.

305. **Teachers' Course.** A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school students are also considered. ½ or 1 unit. Prerequisite: One year of calculus or consent of instructor.

306. **Selected Mathematical Topics for Secondary School Teachers, I.** This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

307. **Selected Mathematical Topics for Secondary School Teachers, II.** This course deals with the teaching of the following topics in high school mathematics: variables in geometry; logic analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as a real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

311. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

312. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

314. **Introduction to Set Theory and Mathematical Logic.** In general, this course supplies the set-theoretic and logical preliminaries for graduate work in mathematics. Contents: sets, relations, and mappings; the notions of constant and variable; the integers; cardinal and ordinal numbers; Zorn's Lemma; the real numbers; informal account of the propositional calculus and first order functional calculus; informal account of various axiomatic theories. 1 unit. Prerequisite: One year of calculus.

315. **Linear Transformations and Matrices.** 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** 1 unit. Prerequisite: Mathematics 327.

332. **Introduction to Set Theory and Topology.** Informal set theory, cardinals, ordinals, Zorn's Lemma, axiom of choice, topology of metric spaces, introduction to general topological spaces, and other topics. 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Introduction to Algebraic Topology.** Fundamental group, complexes, homology, simplicial approximation, structure of Abelian groups, exact sequences, axioms for homology. 1 unit. Prerequisite: Mathematics 318, 332, or consent of instructor.

341. **Differential Equations.** 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** 1 unit Prerequisite: Mathematics 341.

343. **Advanced Calculus.** 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** 1 unit. Credit is not given for both Mathematics 345 and 349. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** 1 unit. Credit is not given for both Mathematics 346 and 348. Prerequisite: Mathematics 347.

349. **Differential Equations and Orthogonal Functions.** An honors course for students with superior mathematical ability. Credit is not given for both Mathematics 349 and 345. 1 unit. Prerequisite: Grade of B or higher in Mathematics 347; and, for undergraduates, registration in Mathematics 249.

350. **Topics in Pure Mathematics.** This is a survey course in pure mathematics for secondary school mathematics teachers. It deals with topics in number theory, topology, and analysis. 1 unit. Prerequisite: Consent of instructor.

351. **Topics in Applied Mathematics.** This is a survey course in applied mathematics for secondary school mathematics teachers. It deals with topics in the application of matrices to physical and social sciences, applications of Boolean algebra, game theory. 1 unit. Prerequisite: Consent of instructor.

353. **Elementary Theory of Numbers.** 1 unit. Prerequisite: One year of calculus.

354. **Elementary Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 or 353.

357. **Mathematical Models in the Social Sciences.** Uses many models drawn from the social sciences to motivate, illustrate, and give a unified development of topics in the following areas: linear algebra, graph theory, Markov chains, and linear and nonlinear systems of difference equations. 1 unit. Prerequisite: Mathematics 134 or equivalent.

358. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. ½ unit. Prerequisite: Mathematics 111 or 112.

359. **Mathematics for Social Scientists.** Only students majoring in the social sciences receive credit for this course. A grade of A or B in this course admits the student to Mathematics 315, 361, 363 and, with consent of instructor, to Mathematics 343. ½ unit. Prerequisite: Mathematics 358.

361. **Theory of Probability.** 1 unit. Prerequisite: One year of calculus.

362. **Finite Differences.** 1 unit. Prerequisite: One year of calculus.

363. **Advanced Statistics.** 1 unit. Prerequisite: One year of calculus.

364. **Advanced Statistics.** 1 unit. Prerequisite: Mathematics 363.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Agronomy 365. A study of methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Students are expected to solve problems on the computers. 1 unit. Prerequisite: Mathematics 195 and a course in statistics or statistical methods or equivalent, or consent of instructor.

366. **Theory of Probability.** Continuation of Mathematics 361. Topics covered may include random walks, Markov chains, branching processes, birth and death processes, and theory of Queues. 1 unit. Prerequisite: Mathematics 361 or 363.

371. **Actuarial Theory.** 1 unit. Prerequisite: One year of calculus. PETERS.

372. **Actuarial Theory.** 1 unit. Prerequisite: Mathematics 371.

375. **Nonparametric Inference.** Nonparametric tests of hypotheses concerning means, variances, regression, and correlation coefficients; methods, depending on ranks; the efficiency of nonparametric tests. 1 unit. Prerequisite: Mathematics 361 or 363.

381. **Vector and Tensor Analysis.** 1 unit. Prerequisite: Mathematics 343 or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

386. **Laplace Transforms.** 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Analysis.** 1 unit. Prerequisite: Mathematics 195 and a course in differential equations, or consent of instructor.

388. **Mathematical Methods in Engineering and Science.** 1 unit. Prerequisite: Mathematics 343.

391. **Boolean Algebra and Switching Theory.** Same as Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. 1 unit. Prerequisite: Consent of instructor.

392. **Introduction to Automata Theory.** Same as Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Mathematics or Electrical Engineering 391, or consent of instructor.

394. **Logical Design of Automatic Digital Computer Circuits.** Same as Electrical Engineering 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for

automatic operation. 1 unit. Prerequisite: Mathematics 294 and senior standing, or consent of instructor.

395. **Programming, Languages and Computation.** An introduction to mathematical models of programming languages and computation on a digital computer; phrase structure languages, particularly context free languages, and their syntactic analysis with application to translation; abstract models of digital computers and the computations which they can perform subject to various restrictions on control, memory, and time; unsolvability results for computations and languages. 1 unit. Prerequisite: Mathematics 195, 295, or consent of instructor.

397. **Mathematical Theory of Data Processing.** Mathematical structure and automatic processing of extensive files of data are developed employing methods from statistics, graph theory, and information theory. Topics discussed include: the selective screening and classification of data (pattern recognition, machine abstracting, optimum encoding, least square adjustment of data); and file organization and maintenance (information retrieval, indexing, scheduling). 1 unit. Prerequisite: Mathematics 195 or consent of instructor.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, is offered by various graduate departments in the sciences and engineering. A graduate student interested in applied mathematics should register as a major in the department of his choice. In consultation with his adviser he should plan a basic course of study which will serve as preparation for subsequent specialization and research in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design.

MECHANICAL AND INDUSTRIAL ENGINEERING

The Department of Mechanical and Industrial Engineering offers work leading to the Master of Science and Doctor of Philosophy. Advanced study and professional training are offered in the general fields of power, design, production, and industrial engineering.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements of the Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 4.0. The applications of those with grade-point averages below 4.0 but above 3.6 are individually reviewed by the graduate committee and admission is granted if credentials are satisfactory. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

Except under unusual circumstances the maximum number of credits which is permitted in any course whose number ends in 8 or 9 is three units toward the requirements for a master's degree. A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is then required.

For further information see *Notes on Graduate Study,* available from the Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the departmental chairman of the graduate committee, Professor Seichi Konzo.

GRADUATE FACULTY

Professors: H. H. Korst (Head of Department), H. D. Bareither, E. L. Broghamer, B. T. Chao, W. L. Chow, L. E. Doyle, G. W. Harper, W. S. Harris, E. F. Hebrank, J. A. Henry, W. L. Hull, S. Konzo, J. L. Leach, R. J. Martin, J. C. Miles, L. C. Pigage, E. I. Radzimovsky, D. G. Ryan, F. Seyfarth, S. L. Soo, W. F. Stoecker, K. J. Trigger.

Associate Professors: W. E. Bair, J. C. Chato, R. G. Hering, B. A. Hertig, E. A. Jackson, D. H. Offner, R. P. Strout, B. F. von Turkovich.

Assistant Professors: A. L. Addy, R. W. Adkins, A. M. Clausing, L. D. Savage, Jr., H. J. Zimmerman.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics and Transport Properties.** Thermodynamic and microscopic considerations for the prediction of properties. Caratheodory principle; relations between properties; microscopic description based on classical statistics; statistical equilibrium and trend toward equilibrium fluctuations; thermodynamics and transport properties; implication of wave mechanics. 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor. Soo.

402. **Irreversible Thermodynamics.** Statistical considerations based on wave mechanics; gases and relativistic modifications; radiation and high temperatures; solids and liquids, systems at low temperatures; reactive systems; electrical and magnetic properties; fluctuations and irreversible thermodynamics. 1 unit. Prerequisite: Mechanical Engineering 301 or equivalent. Soo.

403. **Fundamentals of Combustion.** Same as Aeronautical and Astronautical Engineering 438. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Mechanical Engineering 305 or Aeronautical and Astronautical Engineering 216.

404. **Gas Dynamics.** Introduction to theoretical gas dynamics; properties of compressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multidimensional problems. 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Addy, Chow, Korst.

405. **Convective Heat Transfer.** Fundamentals of convective heat transfer; calculation of heat transfer within conductor and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. Chao, Clausing, Hering.

406. **Heat Conduction in Solids.** Fundamentals of heat conduction in isotropic and anisotropic solids; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques. 1 unit. Prerequisite: Mechanical Engineering 306, Mathematics 346, or consent of instructor. Chao, Hering.

407. **Selected Topics in Gas Dynamics.** Theoretical analysis of nonsteady processes including scavenging, pulse jet, shock tube, and complex compressor. Includes an introduction to high velocity laboratory techniques. 1 unit. Prerequisite: Mechanical Engineering 404. Chow, Korst.

408. **Laboratory Investigation in Thermodynamics.** Special investigations involving thermodynamics analysis, thermodynamic properties, and performance of physical and chemical systems. ½ to 1½ units. Prerequisite: One-year course in thermodynamics; one half-year course in power laboratory. BAIR, JACKSON, SOO.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigation in flow, metering, heat transfer, heat exchanger performance and design. ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. ADDY, BAIR, CHAO, CHOW, CLAUSING, KORST, SAVAGE, WHITE.

410. **Thermal Radiation.** Fundamentals of radiant energy transport in absorbing and non-absorbing media; pyrometry; applications to selected problems involving combined energy transport mechanisms. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. CHAO, HERING.

421. **Heating and Air Conditioning.** Advanced study of heating, ventilating, and air conditioning. Factors affecting heat loss and heat gain of building, physiological effects of environment, equipment design of heat transfer equipment. Individual problems. 1 unit. Prerequisite: Undergraduate course in heating, ventilating, and air conditioning. STOECKER.

423. **Refrigeration Theory and Application.** Advanced study of processes and cycles; design problems; and special applications. 1 unit. Prerequisite: Undergraduate course in refrigeration. CHATO, STOECKER.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. ½ to 1½ units. CHATO, STOECKER.

429. **Laboratory Investigation in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. ½ to 1½ units. Prerequisite: Two semesters of power laboratory or equivalent. CHATO, HARRIS, HERTIG, KONZO, STOECKER.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbocompressors; regulation; rotary positive blowers. 1 unit. Prerequisite: Mechanical Engineering 205, 206, and 212; or Theoretical and Applied Mechanics 232; or Aeronautical and Astronautical Engineering 211. KORST.

438. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. ½ to 1½ units. Prerequisite: One-year course in power laboratory. HEBRANK, HULL, STROUT.

441. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper considerations of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. RYAN

442. **Linkage Synthesis.** Geometry of constrained motion in two and three dimensions; application of mathematical and other techniques to the synthesis of mechanisms. 1 unit. Mechanical Engineering 342 or consent of instructor. BROGHAMER.

443. **Dynamics of Machinery.** Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, flywheels; special topics. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, RYAN.

445. **Design of Internal Combustion Engines.** Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determina-

tion of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. **Laboratory Investigations in Machine Design.** Special investigations in machine design. ½ to 1½ units. ADKINS, BROGHAMER, OFFNER, RADZIMOVSKY, RYAN.

451. **Theory of Metal Cutting.** A study of the theoretical factors involved in metal cutting and forming; basic mechanics of chip formation, friction, surface damage and finish; temperatures and temperature distribution during cutting; wear and tool-work compatability. Analysis of experimental data; critical review of pertinent literature and special topic assignments. 1 unit. Prerequisite: Undergraduate course in principles of metal cutting and heat treatment of metals or physical metallurgy.

452. **Deformation and Mechanical Processing of Metals.** Theoretical and experimental aspects of deformation and mechanical processing of metals. Plastic deformation; fracture and fatigue; impact stresses and stress waves in metals; thermal and residual stresses; plastic forming of metals and its influence on the properties. 1 unit. Prerequisite: Mechanical Engineering 451; Metallurgical Engineering 408. TRIGGER.

458. **Laboratory Investigations in Production.** Special investigations in field of production, particularly in materials processing, metal cutting, and production engineering. ½ to 1½ units. CHAO, TRIGGER, VON TURKOVICH.

493. **Seminar.** Presentation and discussion of significant developments in mechanical engineering. No credit. KONZO.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Thermodynamics.** Basic considerations of the three laws of thermodynamics; elementary statistical principles for the prediction of properties of pure substances and mixtures; transport properties; electric and magnetic systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or equivalent; consent of instructor. JACKSON, SOO.

302. **Nuclear Power Engineering.** Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptation and economics. ¾ or 1 unit. Prerequisite: Consent of instructor.

304. **Direct Energy Conversion.** Direct conversion of chemical, nuclear, and solar energies into electricity by electrochemical, thermionic, thermoelectric, photoelectric, photochemical, ferroelectric, magnetohydrodynamic, and plasma systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor; Mathematics 345. SOO.

305. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or consent of instructor. ADDY, CHOW, WHITE.

306. **Industrial Heat Transfer.** Theory and application of numerical, analogical, and experimental methods to selected heat transfer problems; application of principles of convection, condensation, and boiling heat transfer to design of heat exchange equipment. 1 unit. Prerequisite: Undergraduate courses in fluid mechanics and heat transfer. CLAUSING, HERING, SAVAGE.

309. **Experimental Gas Dynamics.** Experimental investigation of problems in the field of compressible fluid flow within enclosed channels. 1 unit. Prerequisite: Mechanical Engineering 305 or consent of instructor. ADDY, CHOW, WHITE.

311. **Instrumentation and Measurements.** Same as Agricultural Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science.

312. **Theory of Controls.** Introduction to the theory of controls. Dynamical analysis of physical systems; steady-state operations; graphical and analytical methods of analysis; applications. ¾ or 1 unit. Prerequisite: Consent of instructor. VON TURKOVICH.

314. **Lubrication.** The theoretical basis of lubrication; hydrodynamic bearing theory; properties of lubricants; methods of testing; lubrication methods and appliances; study of the lubrication requirements of machines of many kinds. ¾ or 1 unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. ADKINS, OFFNER, RADZIMOVSKY.

332. **Theory of Internal Combustion Engines.** Study of reciprocating engine cycles, including thermodynamics and combustion, considering such factors as fuel-air mixture, variable specific heats, chemical equilibrium and dissociation and heat losses; supercharging; flow through valves and manifolds; mixture distribution; bearings and lubrication; and effects of variables on performance. ¾ or 1 unit. Prerequisite: Undergraduate course in internal combustion engines. HULL.

341. **Engineering Analysis and Design.** Correlation of previously acquired design experience with the creative problems of synthesis and analysis that depend upon design judgment. ¾ or 1 unit. Prerequisite: Mechanical Engineering 271 or consent of instructor. BAYNE, BROGHAMER, WHISENAND.

342. **Kinematic Analysis and Synthesis.** Geometry of constrained motion; application of mathematical and other techniques to the kinematic analysis and synthesis of mechanisms. ¾ or 1 unit. Prerequisite: Undergraduate course in kinematics or consent of instructor. BROGHAMER.

343. **Dynamics of Machinery.** A course complementary to the undergraduate course with emphasis on the analytical approach to the study of dynamic forces in machines, balancing, critical speeds, shaft vibrations, governors, and gyroscopes. ¾ or 1 unit. Prerequisite: Mechanical Engineering 221 or consent of instructor.

388. **Machine Tool Systems Analysis.** A study of the components, their analysis and synthesis in machine tool systems; power components, precision motion, dynamic response of machine skeleton, linear and nonlinear conditions, control elements, and computer control of machines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186, 271, or consent of instructor. VON TURKOVICH.

Industrial Engineering

COURSES FOR GRADUATES

416. **Design of Construction and Industrial Operation, I.** Same as Civil Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor.

417. **Design of Construction and Industrial Operations, II.** Same as Civil Engineering 417. Continuation of Industrial Engineering 416. 1 unit. Prerequisite: Industrial

Engineering or Civil Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

453. **Work Measurement.** A study of special problems of line balance, interference, and automation work loads as required to establish work standards (or production standards) . 1 unit. Prerequisite: Industrial Engineering 332. PIGAGE.

454. **Production Engineering.** Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

458. **Laboratory Investigations in Industrial Engineering.** Special investigations of such problems as optimization of operations, programming systems, work standards, plant layout, and flow of materials. ½ to 1½ units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

332. **Standard Time Systems.** The study of development, uses, and limitations of standard time data and predetermined time system. ¾ or 1 unit. Prerequisite: Industrial Engineering 232. PIGAGE.

333. **Engineering Applications of Statistics.** Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. ¾ or 1 unit. Prerequisite: Mathematics 263 or 363. HENRY.

350. **Manufacturing Process and Tool Design.** A study of and exercises in the design of manufacturing processes and tools for maximum efficiency; the theory and utilization of information transfer systems in manufacturing and programming of numerical control devices. ¾ or 1 unit. Prerequisite: Industrial Engineering 282 or a course in engineering economy. DOYLE.

357. **Safety Engineering.** The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. ¾ or 1 unit. HARPER.

358. **Problems in Safety Engineering.** Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. ¾ or 1 unit. Prerequisite: Industrial Engineering 357, or 235 and consent of instructor. HARPER.

359. **Industrial Fire Protection.** Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. ¾ or 1 unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

386. **Industrial Engineering Analysis.** Analysis and development of analytical techniques for the solution of problems in industrial engineering; application of statistical methods to uncertainty problems; analysis of linear programming techniques appropriate to the solution of allocation problems dealing with materials, money, men, and machines; queueing theories applied to maintenance and inventories. ¾ or 1 unit. Prerequisite: Mathematics 263, Industrial Engineering 286, or consent of instructor.

MICROBIOLOGY

See descriptions and course listings under Life Sciences, page 224.

MINING, METALLURGY, AND PETROLEUM ENGINEERING

The Department of Mining, Metallurgy, and Petroleum Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy. The prerequisite for graduate work in metallurgical or mining engineering is the equivalent of the undergraduate courses in either of these majors which are required for the Bachelor of Science at the University of Illinois. For these major fields a Bachelor of Science in some related field may also be acceptable.

Those wishing to specialize in petroleum engineering or in the more general area of petrophysics should have a Bachelor of Science in engineering with advanced courses in mathematics, chemistry, physics, and/or geology.

A candidate for the Master of Science is required to have a minimum of eight units of graduate work, including a thesis. If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. The thesis requirement is not waived for research assistants.

Students desiring to work for the Doctor of Philosophy are required to pass the departmental qualifying examination. This examination must be taken no later than the end of the first semester after receiving the Master of Science from this department, or no later than the end of the second semester in residence, if the student has a Master of Science from some other department or university.

The minor requirement of the Graduate College for the Doctor of Philosophy may be satisfied by taking courses in fields such as ceramics, chemistry, geology, mathematics, theoretical and applied mechanics, nuclear engineering, and physics.

GRADUATE FACULTY

Professors: T. A. Read (Head of Department), P. A. Beck, H. K. Birnbaum, R. W. Bohl, W. H. Bruckner, A. J. de Witte, E. J. Eckel, J. J. Gilman, D. S. Lieberman, M. Metzger, B. G. Ricketts, H. E. Risser, W. D. Rose, T. J. Rowland, A. E. Scheidegger, N. Street, R. M. Thomson, C. M. Wayman, C. A. Wert, F. D. Wright.

Associate Professor: C. J. Altstetter.

Assistant Professor: S. J. Golin.

Mining Engineering

COURSES FOR GRADUATES

401. **Advanced Mineral Dressing and Coal Preparation.** Advanced theory and practice of mineral dressing and coal preparation processes. 1 unit.

402. **Mine Valuation, Taxation, and Mineral Economics.** A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. 1 unit.

403. **Advanced Mine Administration.** Current methods and systems of mine administration in use by major mining corporations. 1 unit.

405. **Advanced Mine Ventilation.** Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. 1 unit. Prerequisite: Consent of instructor.

406. **Design of Underground Openings.** Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. 1 unit. Prerequisite: Mining Engineering 356.

497. **Special Problems.** Individual studies in areas of mining or petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** Individual research in some phase of the general field of mining or petroleum engineering under the supervision of a member of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Mineral Processing.** Crushing, grinding, flotation, proximate analysis of coal, pumping of fluid-solid mixtures, quality control in ore dressing. ¾ unit.

302. **World Mineral Economics.** The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. ¾ or 1 unit.

303. **Materials Handling: Fluids.** Design of water systems for unwatering and dust control in mines; compressed air distribution systems and analysis of mine ventilation and air conditioning. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 234; Mechanical Engineering 209 or Chemistry 344.

351. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor.

353. **Sampling, Exploration, Valuation.** Theory of sampling applied to mineral deposits and concentrating plants; geological principles of exploration; surface and subsurface exploration; valuation. ¾ or 1 unit. Prerequisite: Geology 101 and 130; Mathematics 263.

356. **Rock Mechanics.** Mechanical properties of rocks; design of mine openings in bedded, massive, and fractured rock; methods of support; drilling; blasting. ¾ or 1 unit. Prerequisite: Mining Engineering 351.

360. **Analysis and Design of the Mining System.** Analyses of unit operation cycles and production methods; design of materials handling systems and applications of operations research. 1 unit. Prerequisite: Mathematics 263; credit or registration in Mining Engineering 356.

396. **Seminar.** Review of mining and petroleum literature; reports; technical writing. ¼ unit.

Metallurgical Engineering

COURSES FOR GRADUATES

405. **Advanced Physics of Metals.** Introduction to quantum mechanics, theory and experiment, potential barrier problem, hydrogen atom, perturbation theories, application to the study of solids. 1 unit. Prerequisite: Mathematics 343 and 345; Physics 381 or 383; Metallurgical Engineering 318; or consent of instructor.

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. 1 unit. Prerequisite: Metallurgical Engineering 405, or Physics 385, or consent of instructor.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. 1 unit. Prerequisite: Consent of instructor.

408. **Dislocations and Mechanical Properties of Metals.** General static and dynamic properties of single dislocations in crystals; dislocation interactions; properties of dislocation arrays; role of dislocations in metallurgical phenomena with particular emphasis on mechanical properties. 1 unit. Prerequisite: Consent of instructor.

409. **Crystal Physics.** The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction and diffusion, thermoelectricity, deformation, elasticity, and martensitic transformations. The effects of crystal symmetry and the properties of aggregates are discussed. 1 unit. Prerequisite: Vector algebra, determinants, and thermodynamics; consent of instructor.

410. **Advanced X-Ray Metallography.** X-ray diffraction as applied to the study of metals and alloys; effects of cold work, annealing, substructures, preferred orientation and ordering, principles of electron and neutron diffraction. 1 unit. Prerequisite: Chemistry 427 or consent of instructor.

420. **Metallurgical Thermodynamics.** Fundamental thermodynamic considerations and applications of thermodynamics to metallurgical problems; particular emphasis on heterogeneous equilibrium and thermodynamic properties of solutions; topics approached from the viewpoints of both macroscopic thermodynamics and statistical mechanics. 1 unit. Prerequisite: Metallurgical Engineering 314 or equivalent.

421. **Kinetics of Phase Changes in Metals.** The viewpoint of statistical thermodynamics, rate theory, diffusion in solids, interface energy, nucleation theories, phenomenological analysis of nucleation and growth; application to crystal growth, diffusionless phase changes, oxidation, pearlite reaction, precipitation, sintering. 1 unit. Prerequisite: Metallurgical Engineering 420 or consent of instructor.

485. **Metallurgical Engineering Problems.** Individual study in areas of metallurgical engineering not covered by regular course offerings, carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: Consent of instructor.

486. **Laboratory Investigations in Metallurgy.** Special investigations in metallurgy to provide an opportunity to employ some advanced experimental methods of research. Available only to non-thesis students enrolled in a Master of Science program. ¼ or ½ unit. Prerequisite: Consent of instructor.

493. **Seminar in Anelasticity.** Lectures and discussions of the nature of anelasticity and its application to metallurgy. 0 or ¼ unit. Prerequisite: Consent of instructor.

494. **Seminar on Phase Transformations in Metals.** Discussion of current research in this field including presentation by graduate students of their own work. 0 or ¼ unit. Prerequisite: Consent of instructor.

495. **Seminar on Diffusion and Imperfections.** Lectures and discussions on diffusion and imperfections in crystalline solids. 0 or ¼ unit. Prerequisite: Consent of instructor.

497. **Seminar on Alloy Phases.** Discussion and lectures on current research, including work by the graduate students, relating to the electronic structure and crystal structure of alloy phases. 0 or ¼ unit. Prerequisite: Consent of instructor.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical research in other laboratories by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. No credit.

499. **Thesis Research.** Individual research in specialized problems under the supervision of members of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Metallurgy of Welding.** Heat flow and thermal cycles in welding and cutting of metals; physical metallurgy and mechanical properties of weld metal and thermally altered base metal; joining methods in relation to composition, microstructure, and mechanical properties; specifications, economics, and service requirements. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 or equivalent.

302. **Powder Metallurgy.** Production and testing of powdered metals; fabrication and application of metal shapes produced from powdered metals. ½ or ¾ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304.

304. **Powder Metallurgy Laboratory.** Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302.

306. **Design of Engineering Alloys.** A study of the fundamental principles which determine the constitution, structure, treatment, and application of alloy steels and other special-purpose high-performance alloys. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 and 311.

307. **Corrosion of Metals.** Electrochemistry, thermodynamics, and kinetics of corrosion; behavior of ferrous and nonferrous metals; corrosion rates; corrosion control, cathodic and anodic protection; high-temperature corrosion; corrosion testing; electrolytic machining methods. ¾ or 1 unit. Prerequisite: Mechanical Engineering 234 or equivalent.

310. **X-Ray Metallography.** X-ray generation and scattering with applications to problems in physical metallurgy, such as phase identification, the determination of solid solubility, the measurement of grain size and preferred orientation, and other topics. ¾ unit. Prerequisite: Physics 108.

311. **Advanced Phase Diagrams.** Interpretation of multicomponent phase diagrams for metal systems. ½ unit. Prerequisite: Metallurgical Engineering 201 or equivalent.

314. **Metallurgical Thermodynamics.** Thermodynamic principles are applied to the study of phase and chemical equilibrium and to the calculation of free energy of phases. ¾ unit. Prerequisite: Credit or registration in Chemistry 246.

315. **Metallurgical Kinetics.** Diffusion and heat flow calculations and their applications to kinetics of metallurgical processes. ¾ unit. Prerequisite: Metallurgical Engineering 208 and 314.

316. **Mechanical Metallurgy.** Fundamentals of plastic deformation of metals; theory and techniques of rolling, deep drawing, extrusion, and rod and wire drawing; metallurgical defects and difficulties encountered in metal forming. ¾ unit. Prerequisite: Senior standing in metallurgical engineering or consent of instructor.

318. **Physics of Metals.** The nature of the perfect and imperfect crystal, the electronic structure of solids, electrical conduction in metals and semiconductors, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Senior standing in engineering or consent of instructor.

384. **Properties of Solids.** Perfect and imperfect crystal lattices, electronic structure of solids including basic theory and applications to transport properties of metals and semi-conductors, semi-conductor diodes; dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

385. **Structural Physical Metallurgy.** A comprehensive survey of selected areas of structural physical metallurgy, excluding electronic processes. Not open to graduate students with an undergraduate major in metallurgy. ¾ unit. Prerequisite: Physical chemistry or classical thermodynamics; differential equations; consent of instructor.

Petroleum Engineering

COURSES FOR GRADUATES

420. **Porous Media Hydromechanics.** Introduction to theoretical hydromechanics. Classification of fluids, fundamental laws and basic equations of motion applica-

ble to microscopic and macroscopic regimes; treatment of interfacial forces and surfaces in multi-phase flow as particularly applied to porous media systems. ¾ or 1 unit. Prerequisite: Mathematics 343, Petroleum Engineering 373, or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

371. **Reservoir Mechanics, I.** The mechanics of the movement of fluids in the porous rock reservoirs of the subsurface, especially as related to questions dealing with the production and storage of petroleum fluids, ground water, and natural gases. 1 unit. Prerequisite: Mathematics 345; Theoretical and Applied Mechanics 235.

372. **Reservoir Mechanics, II.** A continuation of Reservoir Mechanics, I, showing the application of the fundamental concepts in developing procedures for forecasting the future performance of reservoir systems as derived from a knowledge of initial and boundary conditions, and as derived with reference to the past history of fluid movement and displacement. 1 unit. Prerequisite: Petroleum Engineering 371.

373. **Advanced Reservoir Engineering.** Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. ¾ or 1 unit. Prerequisite: Mathematics 345, Petroleum Engineering 372, or consent of instructor.

MUSIC

The School of Music offers the Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Master of Music. The major field may be in musicology, music theory and composition, or performance and literature (organ, voice, piano, violin, viola, cello, solo wind instruments, and percussion instruments) .

The admission requirement, in terms of grade-point average, is at least 3.5. In addition, an applicant is required: (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or its equivalent, at the University of Illinois or another accredited institution; and (2) to pass a qualifying examination in the major field of concentration. If the major is to be performance and literature, this examination is essentially one of performance on the major instrument. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of German or French is required. Candidates in voice should have had one year each of French, German, and Italian, unless two years of one language have been completed in high school. All prospective candidates for the Master of Music must take a placement examination in the history of music and the theory of music.

Doctor of Musical Arts. The fields of specialization for this degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree programs comprise the following major areas: composition, choral music, piano, organ, violin, viola, cello, voice, and wind instruments.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. The prerequisites for admission are as follows:

(1) The Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent) :

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units;

(b) Major in Performance and Literature: performance and literature, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) A high level of proficiency in composition or performance.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, psychology, and philosophy. Students lacking an appropriate background in liberal arts and sciences may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination.

(5) Successful completion of qualifying examinations. These examinations in performance and literature, the history of music, and the theory of music must be taken within the first two or three weeks of the first semester or summer session in residence. Prospective applicants should write to the School of Music, 100 Smith Music Hall, for complete information concerning the nature of these examinations.

If the candidate fails to pass the qualifying examinations, he must repeat and pass all or parts of them no later than the end of the second semester in residence. Until the examinations have been passed, the student is considered to have a provisional status.

After admission to the doctoral program the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, calendar, grades, and major and minor fields.

A minimum of sixteen units of graduate credit beyond the eight units required for the Master of Music is necessary to earn the Doctor of Musical Arts. In the fields of composition, and performance and literature, three units are devoted to the completion of a special doctoral project: for the former, the writing of an original score on a large scale; for the latter, the study of a comprehensive repertory and either two solo recitals, or one solo recital and two of the following options: (1) a concerto performance; (2) the performance of a major role in an opera or oratorio; (3) a chamber music program; (4) a lecture recital; (5) a coaching performance of an instrumental or vocal ensemble. Two units are devoted to the completion of an original thesis. In the field of choral music, one unit is devoted to a doctoral project involving the preparation and presentation of a choral program of approximately one hour in length selected from a comprehensive repertory. Four units are devoted to the completion of an original thesis.

In addition to the foregoing, the work includes the following required courses: composition or performance and literature, three units; Music 420, Seminar in Music Literature for Doctoral Candidates, two units. One unit of work must be taken in the field of education or music education unless the candidate has previously passed equivalent course work. At least two, but no more than four, units are devoted to an outside minor field.

Three of the six units of electives must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College.

Doctor of Philosophy in Musicology. The Doctor of Philosophy in Musicology is intended for applicants whose interests lie in research in the history of music, theory of music, psychology of music, ethnomusicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see pages 20 to 23), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program.

Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the Master of Music with a major in musicology or theory of music; (2) have acquired a background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, psychology, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the sixteen units must be in Music 499 and are devoted to the completion of an original doctoral thesis. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or the equivalent, in courses including Music 320, 322, 414, 415, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in performance.

(2) A minimum of two units in one or two minor fields.

(3) In addition to the general foreign language requirements of the Graduate College, proficiency in Latin is expected. An examination in one or more additional foreign languages may be required when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(4) A preliminary examination administered by a committee appointed by the Dean of the Graduate College.

Master of Science in Music Education. Candidates for this degree must earn four units in music, two units in education, and two units in electives. Requirements are four units of music; two courses from History and Philosophy of Education 301, 302, 303, 304, one unit; Educational Psychology 311 and 312, one unit; and electives, two units. The electives may be in music, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy placement examinations in music history, music theory, and performance and literature in the principal music area.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music history, music theory, and applied music.

Residence. At least four units must be earned in residence on the Urbana campus. This requirement may be met by spending one full semester or two eight-week summer sessions in residence.

Program. A minimum of eight units beyond the master's degree is required. Music 440 and 441 and either Educational Psychology 411 or 412 are required. The remainder of the program is based upon the student's needs and interest and upon the deficiencies revealed in placement tests. No more than one unit of performance and literature may be counted toward the certificate.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Doctor of Education. The program leading to the Doctor of Education with a major in music education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations are administered by the School of Music in music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. At least sixteen units of work beyond the master's degree are required, including six units in music courses and six units in education courses. No more than two units of credit in applied music may be counted toward the degree.

The following courses are required: History and Philosophy of Education 410, Educational Psychology 415, Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. For work completed elsewhere, see page 38. Extramural course work may not be included as part of this sixteen-unit requirement.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

GRADUATE FACULTY

Professors: D. A. Branigan (Director of School of Music), B. Bergethon, G. W. Binkerd, Dorothy E. Bowen, H. A. Decker, S. Fletcher, B. R. Foote, J. C. Garvey, S. Goldthwaite, B. M. Goodman, C. E. Hamm, M. H. Hindsley, G. H. Hunter, K. Kellogg, J. R. Kelly, Colleen J. Kirk, E. D. Kisinger, C. Leonhard, A. J. McDowell, P. S. Pettinga, Claire L. Richards, A. L. Ringer, P. Rolland, H. C. Schmitt, H. O. Sexton, S. Stravinsky, R. H. Swenson, P. Ulanowsky, G. R. Waller, Grace E. Wilson, Velma K. Wilson, L. E. Zirner.

Associate Professors: J. L. Bailey, E. S. Berry, A. M. Carter, Dorothy E. Clark, W. R Coggins, C. O. DeLaney, B. E. Edlefsen, P. S. Farrell, L. T. Fredrickson, K. L. Gaburo, R. E. Gray, R. J. Hamilton, L. A. Hiller, T. L. Holden, B. B. Johnston, H. Karp, C. J. Kleinsteuber, E. J. Krolick, J. H. McKenzie, W. H. Miller, B. Nettl, P. Painter, D. W. Sanders, R. E. Thomas.

Assistant Professors: Mary M. Burdette, R. J. Colwell, A. Hughes, R. B. MacDonald, S. J. Martirano, Evelyn Reynolds, R. B. Smith.

Instructors: D. B. Gilbert, Jane E. Schleicher, A. R. Thomas.

COURSES FOR GRADUATES

400. **Advanced Instrumentation: Chamber and Symphonic.** Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. **Advanced Instrumentation: Band.** Arrange for the concert band, works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. HINDSLEY.

402. **Analysis in Relation to Performance and Interpretation, I.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. LEONHARD.

403. **Analysis in Relation to Performance and Interpretation, II.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. 1 unit. Prerequisite: Music 402. LEONHARD.

406. **Composition.** Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. ½ to 1½ units. COMPOSITION FACULTY.

410. **History of Music Theory.** 1 unit. Prerequisite: Graduate standing in musicology or composition, or consent of instructor. HUGHES.

411. **Introduction to Ethnomusicology.** A comprehensive survey of concepts, problems, and methods of research in non-Western and folk music. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. NETTL.

412. **History of Musical Aesthetics, I.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles. From Pythagoreanism to the humanistic period. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Graduate standing in music. RINGER.

413. **History of Musical Aesthetics, II.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles from the seventeenth century to the present day. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 412. RINGER.

414. **Notation, I.** The history of notation from its beginning to 1400. ½ unit. Prerequisite: Consent of instructor. GOLDTHWAITE.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. ½ unit. Prerequisite: Music 414 or consent of instructor. GOLDTHWAITE.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 312 or consent of instructor. GOLDTHWAITE.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 416 or consent of instructor. GOLDTHWAITE.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory, and aesthetics of opera. The principal composers covered are Monteverdi, Cavilli, Cesti. Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. ½ or 1 unit. Prerequisite: Music 312 or consent of instructor. HAMM.

419. **The History of Opera from Mozart to the Present.** A detailed examination of stylistic and structural developments in opera after Gluck, with special reference to representative works from Mozart to Schoenberg viewed in relation to the general musical and cultural background of their time and place of origin. ½ or 1 unit. Prerequisite: Music 312 and 313, or consent of instructor. RINGER.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students (except those in choral music) enrolled in the Doctor of Musical Arts program. 1 unit; maximum accumulated credit, two units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. **Seminar in Music Education.** An introduction to problems and methods of research in music education. Required of all candidates for the Doctor of Education in music education. 1 unit. Prerequisite: Graduate standing in music education or consent of instructor. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. ½ or 1 unit. Prerequisite: Graduate standing in music theory or consent of instructor. KESSLER.

423. **Seminar in Musicology.** Problems in historical and systematic musicology; discussions of special problems and reports on individual research. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. HAMM, RINGER.

424. **Bach, I.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music.

425. **Bach, II.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music.

426. **Beethoven, I.** ½ or 1 unit. Offered in 1967-1968 and in alternate years. KESSLER.

427. **Beethoven, II.** ½ or 1 unit. Offered in 1967-1968 and in alternate years. KESSLER.

428. **Problems and Methods.** An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports of bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. 1 unit. REVITT.

429. **Historical Studies in Twentieth-Century Music.** A seminar in contemporary music, with emphasis on the historical foundations of current trends in musical composition. ½ to 1 unit; maximum accumulated credit, two units. Prerequisite: Music 315, 422, or equivalent.

430. **Advanced Orchestra Conducting and Literature.** Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestras. 1 unit. Prerequisite: Previous conducting experience. GOODMAN.

431. **Advanced Band Conducting and Literature.** Study of problems and techniques of band conducting and a survey of literature for the concert band. 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Techniques.** An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. **Advanced Choral Literature and Conducting.** An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. 1 unit. Prerequisite: Graduate standing in music education, Music 432 or equivalent, or consent of instructor. DECKER.

434. **Piano Literature.** 1 unit; maximum accumulated credit, two units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. KESSLER.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. 1 unit; maximum accumulated credit, two units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. KELLOGG.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, two units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. PETTINGA.

437. **String Instrument Literature.** 1 unit; maximum accumulated credit, two units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. FARRELL.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, two units. EDLEFSEN, KISINGER.

439. **Percussion Instruments Literature.** An integrating course offering the opportunity to survey and analyze the field of solo and ensemble percussion literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, two units. Prerequisite: Graduate standing in music; consent of instructor. MCKENZIE.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction. supervision, administration and evaluation in music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. ½ or 1 unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

444. **The General Music Program in Elementary Schools.** A detailed consideration of elementary general music, its objectives, organization, operation. Special attention is given to materials and methods of teaching. ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. **Seminar and Laboratory in Musical Acoustics, I.** Special topics in acoustics, including formant theory and communication theory; application of electrical and electronic techniques to music reproduction and propagation; audio-visual aids. ½ or 1 unit. Prerequisite: Graduate standing in music or music education, or consent of instructor. HILLER.

447. **Seminar and Laboratory in Musical Acoustics, II.** Techniques of modern experimental electronic music; related music theory; computational music and related topics. Individual projects for selected students. ½ or 1 unit. Prerequisite: Music 446 or consent of instructor. HILLER.

450. **History of Vocal Ensemble and Choral Music, I.** A critical and analytic study of vocal and choral ensemble music from the Middle Ages to 1750. 1 unit; S, ½ unit. HAMM.

451. **History of Vocal Ensemble and Choral Music, II.** A critical and analytic study of vocal and choral ensemble music from 1750 to the present. 1 unit; S, ½ unit. HAMM.

480. **Piano.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

481. **Voice.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

482. **Organ.** Selected studies from the masterworks of organ literature. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

483. **String Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

484. **Wind Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

485. **Percussion Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

489. **Doctoral Projects.** Special projects for candidates for the Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. 1 to 3 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

499. **Thesis Research.** Research in special projects. 0 to 4 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Eighteenth-Century Counterpoint.** The study of the technique of contrapuntal writing as found in the works of J. S. Bach and other eighteenth-century composers. Imitation, canon, invertible counterpoint, two- and three-part inventions, etc., are studied through writing and analysis of compositions by eighteenth-century composers. ½ unit. Prerequisite: Music 104 and/or consent of instructor. BINKERD, FREDRICKSON, KELLY.

301. **Fugue.** The study of fugal writing during the eighteenth and early nineteenth centuries. A continuation of the study of tonal counterpoint begun in Music 300, with special emphasis on the study and analysis of the fugal works of J. S. Bach, Handel, and Beethoven and on the writing of fugues and part fugues. ½ unit. Prerequisite: Music 300 and/or consent of instructor. BINKERD, FREDRICKSON, KELLY.

302. **Musical Acoustics, I.** A survey of basic topics in the physics of music: wave motion and the physical properties of sound; the ear and hearing; timbre, formant theory, and the acoustical properties of musical instruments. ½ unit. Prerequisite: Consent of instructor. HILLER.

303. **Musical Acoustics, II.** Acoustics, mathematics, aesthetics of pitch organization in music; scales, tuning, and temperament; pitch and rhythm, and their structural interrelationships; theories of perception of pitch and rhythm. ½ unit. Prerequisite: Music 302 and/or consent of instructor. JOHNSTON.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used and includes the study of form and harmony as these bear on the problems. ½ unit. Prerequisite: Music 104 or consent of instructor. A. R. THOMAS.

305. **Analytical Techniques, II.** Continuation of Music 304, beginning with the early seventeenth century and coming down to the present day. ½ unit. Prerequisite: Music 304 or consent of instructor. A. R. THOMAS.

306. **Composition.** Work in original composition including the small and large homophonic forms. ½ or 1 unit. Prerequisite: Music 104 or 106, or consent of instructor. COMPOSITION FACULTY.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. ½ unit. Prerequisite: Consent of instructor. BINKERD.

308. **Analysis of Musical Form.** An intensive study of representative compositions of the sixteenth through the twentieth centuries for structure and form. ½ unit. Prerequisite: Music 104 and 109, or consent of instructor. FARRELL.

309. **Seminar in Music for Dance.** Theory and practice of combining sound and movement in theatrical dance. Individual projects providing experience in collaboration for both composers and choreographers. ½ unit. Prerequisite: Music 106, 306, or Dance 265 and/or consent of instructor. A. R. THOMAS.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HUGHES.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HUGHES.

312. **Music of the Baroque and Classical Period.** A history of music from about 1600 to 1800. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HANSELL.

313. **Music of the Nineteenth and Twentieth Centuries.** A history of music from about 1800 to the present. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. RINGER.

314. **History of Musical Instruments.** The evolution of instruments, both Western and non-Western, considered in their social and cultural settings; construction and playing techniques of instruments treated in relation to performance practice and stylistic developments. ½ unit. Prerequisite: Music 213 and 214, or consent of instructor. NETTL.

315. **Contemporary Music.** A survey of all important trends, forms, and styles of modern music from 1875 to the present. ½ unit. Prerequisite: Consent of instructor. MACDONALD.

316. **Introduction to Music of the World's Cultures.** Same as Anthropology 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. **Area Studies in Ethnomusicology.** Same as Anthropology 315. A seminar devoted to intensive study in the music of one specific culture, e.g., (a) Japan, (b) China, (c) Indonesia, (d) India, (e) the Near East, (f) African and New World Negro, (g) European and American folk cultures, (h) American Indian. ½ unit. Prerequisite: Senior standing in music or consent of instructor. NETTL.

318. **History of Performance Practices, I.** The study of musical performance from about 900 to 1600. Discussion of musical instruments, makeup of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. **History of Performance Practices, II.** The study of musical performance from 1600 to 1750. Discussion of musical instruments, ornamentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. **Proseminar.** Provides special preparation in specialized fields of musicology, music education, theory, and composition. ½ or 1 unit; maximum accumulated credit, two units. Prerequisite: Senior or graduate standing in music or music education; consent of instructor. GRADUATE FACULTY.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. ½ or 1 unit; maximum accumulated credit, two units. Prerequisite: Senior or graduate standing in music, or consent of instructor. HAMM.

323. **Opera Production, I.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 265 and 381; consent of instructor. ZIRNER.

324. **Opera Production, II.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 323. ZIRNER.

330. **Applied Music Pedagogy.** A survey of techniques, practices, and materials; presentation of group and individual instruction; an approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. ½ unit; maximum accumulated credit, 1 unit. Prerequisite: Consent of instructor. LYKE, MILLER, ROLLAND, G. WILSON.

332. **Church Music Literature.** A survey of the development of church music with emphasis on the period since 1500. ½ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 214 or 311, or consent of instructor. HAMILTON.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. ½ unit. Prerequisite: Music 332 or consent of instructor. HAMILTON.

334. **The Music of America, I.** A study of folk, popular, and art music in America from the time of the first European settlers through the middle of the nineteenth century; psalmody, early opera and concert life, African and European folk music, the singing school, music of European immigrants, and the roots of jazz. ½ unit. Prerequisite: Senior standing in music or consent of instructor. HAMM.

335. **The Music of America, II.** A study of chamber, choral, and orchestral music written by American composers from 1850 to the present; jazz and its offshoots; folk and popular music, and experimental music in America. ½ unit. Prerequisite: Senior standing in music or consent of instructor. HAMM.

340. **Instrumental Clinic and Band Pageantry.** A study of the peculiarities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing, charting and show continuity, marching fundamentals, and special problems. ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

341. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

342. **Percussion Methods.** Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. ½ unit. Prerequisite: Senior or graduate standing in music education; Music 174 and 257, or equivalent. McKenzie.

344. **Methods of String Class Teaching.** Designed primarily for teachers of school music who are not performers on a string instrument, yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Senior or graduate standing in music education or consent of instructor. Waller.

345. **Teaching Techniques of Music Theory.** Teaching materials, methods, texts, and pedagogical sequence are discussed and analyzed, including an intensive survey of the structural materials normally covered during the first two years of collegiate study. ½ unit. Prerequisite: Music 300 or consent of instructor. Carter.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit; maximum accumulated credit, two units. Prerequisite: Senior or graduate standing in music education or consent of instructor. Bergethon, Leonhard, R. E. Thomas.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1966 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. McDowell, Woodwind Faculty.

348. **Teaching of Brass Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1967 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. Sexton, Brass Faculty.

349. **Music in Early Childhood.** A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. ½ unit. Prerequisite: Senior or graduate standing in music education or child development. Smith.

350. **Advanced Ensemble Music.** Selected projects in the study and performance of ensemble literature including the areas of operatic, instrumental, and vocal-choral literature and accompanying. ½ unit; S, ¼ unit. Prerequisite: Registration in applied music at the 300 level; consent of instructor. Garvey, Hunter, Swenson, Zirner.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

377. **Class Piano (Advanced).** An integrated course in piano instruction with emphasis placed upon the acquisition of keyboard knowledges and skills essential for effective school music teaching; includes work in harmonization, transposition, improvisation, and vocal and instrumental score reduction. ½ unit. Prerequisite: Music 104, 109, 180, or consent of instructor. Lyke.

380. **Piano.** ½ or 1 unit; S, ¼ or ½ unit. Bilson, Fletcher, Karp, Richards, Sanders, Stravinsky, Zirner.

381. **Voice.** ½ or 1 unit; S, ¼ or ½ unit. Bailey, Bowen, Burdette, Clark, Foote, Kellogg, Miller, Reynolds, G. Wilson.
382. **Organ.** ½ or 1 unit; S, ¼ or ½ unit. Hamilton, Pettinga.
383. **Violin.** ½ or 1 unit; S, ¼ or ½ unit. Rolland, Schmitt.
384. **Viola.** ½ or 1 unit; S, ¼ or ½ unit. Garvey.
385. **Cello.** ½ or 1 unit; S, ¼ or ½ unit. Farrell, Swenson.
386. **String Bass.** ½ or 1 unit; S, ¼ or ½ unit. Krolick.
387. **Flute.** ½ or 1 unit; S, ¼ or ½ unit. DeLaney.
388. **Clarinet.** ½ or 1 unit; S, ¼ or ½ unit. Coggins, McDowell.
389. **Oboe.** ½ or 1 unit; S, ¼ or ½ unit. Edlefsen.
390. **Bassoon.** ½ or 1 unit; S, ¼ or ½ unit. Berry.
391. **Cornet and Trumpet.** ½ or 1 unit; S, ¼ or ½ unit. Sexton.
392. **French Horn.** ½ or 1 unit; S, ¼ or ½ unit. Holden.
393. **Trombone.** ½ or 1 unit; S, ¼ or ½ unit. Gray.
394. **Baritone.** ½ or 1 unit; S, ¼ or ½ unit. Gray.
395. **Tuba.** ½ or 1 unit; S, ¼ or ½ unit. Gray.
396. **Percussion.** ½ or 1 unit; S, ¼ or ½ unit. McKenzie.
397. **Harp.** ½ or 1 unit; S, ¼ or ½ unit. Kleinsteuber.
398. **Saxophone.** ½ or 1 unit; S, ¼ or ½ unit. Coggins.
399. **Harpsichord.** ½ or 1 unit; S, ¼ or ½ unit. Hunter.

NUCLEAR ENGINEERING

Nuclear engineering offers work leading to the Master of Science and Doctor of Philosophy and provides courses and research facilities for doctoral candidates in nuclear engineering and related fields.

The programs in nuclear engineering are open to all graduates in engineering, mathematics, and the physical sciences who have a grade-point average of at least 4.0 out of 5.0 for the last two years of undergraduate work. Students with grade-point averages below 4.0 but above 3.5 are considered individually. Applicants who fall in this latter category are invited to support their applications with a letter explaining the circumstances. It is recommended that they also submit letters of reference and information as to their rank in class.

Undergraduate courses in differential equations, advanced calculus, atomic physics, and nuclear physics are required as background for the nuclear engineering program. A student may be admitted before he has completed these four prerequisites, but he must then allow an additional semester or summer of study for completion of the master's degree.

The general requirements of the Graduate College must be met for either degree. Specific requirements for the degrees in nuclear engineering are as follows:

(1) The master's degree requires eight units including a thesis, or nine units without a thesis. At least four of these units must be in nuclear engineering courses. The remaining courses are electives which must be approved by the candidate's adviser.

(2) Excluding the thesis requirement, a candidate for the doctor's degree must complete a minimum of sixteen units of graduate work. Six of these units must be in nuclear engineering. An integrated group of at least four units of graduate courses in an established engineering discipline or in one of the physical sciences is strongly recommended.

A 250-kilowatt TRIGA Mark II reactor is located on campus for research and teaching in nuclear engineering. The reactor can be pulsed to power levels of 1000 megawatts for special studies. Teaching facilities include a nuclear metallurgy laboratory, a radiochemistry and nuclear instrumentation laboratory, a boiling water

heat transfer loop, several subcritical natural uranium assemblies, a waste disposal laboratory, a shielding laboratory, and a direct energy conversion laboratory.

For further information, see the brochure *Graduate Program in Nuclear Engineering*, available from the Nuclear Engineering Office, 214 Nuclear Engineering Laboratory.

GRADUATE FACULTY

Professors: M. E. Wyman (Chairman of Nuclear Engineering Program), F. T. Adler, A. W. Allen, R. W. Bohl, A. P. Boresi, B. T. Chao, A. B. Chilton, B. B. Ewing, L. Goldstein, C. D. Hendricks, J. S. Koehler, R. J. Martin, M. S. McVay, J. E. Pearson, S. L. Soo.

Associate Professors: G. A. Costello, D. F. Hang, J. P. Hummel, G. H. Miley.

Assistant Professors: J. L. Brownlee, Jr., J. G. Kay, K. Preiss, N. H. Schilmoeller.

Instructor: B. G. Jones.

COURSES FOR GRADUATES

401. **Fundamentals of Nuclear Engineering.** A lecture and problem course to provide background for further work in nuclear engineering. Problems in materials, heat transfer, and fluid flow. Special emphasis is given to basic ideas and the mathematical similarity of problems in heat transfer, fluid flow, and neutron diffusion. 1 unit. Prerequisite: Physics 282 or 382 and Mathematics 345, or equivalent, or consent of instructor.

411. **Nuclear Reactor Heat Transfer.** Selected topics in nuclear reactor heat transfer: thermal analysis of fuel elements under steady and transient operation, convective energy transport from reactor cores, two-phase flow and boiling in reactor cores, and liquid metal coolant systems. ¾ to 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

421. **Nuclear Concepts.** Selected topics in low-energy nuclear physics of general interest to the nuclear engineering field; nuclear reactions, cross sections, slowing down and interactions with matter, decay theory, and nuclear forces. 1 unit. Prerequisite: Physics 282 or 382; consent of instructor.

431. **Nuclear Metallurgy.** Metallurgical principles applied to materials problems in nuclear engineering, including topics in production of uranium, corrosion, radiation damage, fuel element fabrication, and fuel reprocessing. 1 unit. Prerequisite: Consent of instructor.

441. **Nuclear Radiation Shielding.** Radiation units and measurement; tolerance limits; interaction of radiation and matter; geometry factors in attenuation; gamma ray and neutron attenuation; moment theory for attenuation; application to reactors, protective shelters, and space vehicles. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

447. **Radioactive Waste Disposal.** Same as Civil Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous waste disposal; air monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282 or Nuclear Engineering 398 (Chemistry 398), or consent of instructor.

451. **Reactor Laboratory.** Reactor operation: start-up, changes in power level, and shutdown. Reactor instrumentation: subcritical assemblies; flux measurements in core and thermal column; control rod worth measurements; effects of changes in fuel configurations; activation and neutron beam experiments. ½ or 1 unit. Prerequisite: Consent of instructor.

454. **Nuclear Engineering Laboratory Investigations.** Individual laboratory investigations in nuclear engineering. ½ to 1½ units. Prerequisite: Consent of instructor.

455. **Reactor Physics, I.** Same as Physics 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections; diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Mathematics 343 and 345, Nuclear Engineering 347, or consent of instructor.

456. **Reactor Physics, II.** Same as Physics 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Nuclear Engineering 455 or consent of instructor.

458. **Nuclear Reactor Engineering.** Development of engineering design phases of the fission chain reactor: reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. 1 unit. Prerequisite: Consent of instructor.

460. **Reactor Kinetics.** Discussion of special topics such as response of reactor systems to changes of power demand and reactivity. Transfer function analysis, nonlinear problems of reactor dynamics, reactor stability; fuel cycles; digital and analog computer methods for solving reactor kinetic problems. 1 unit. Prerequisite: Nuclear Engineering 401 and 455, or consent of instructor.

467. **Thermomechanics of Nuclear Reactor Systems.** Same as Theoretical and Applied Mechanics 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal shock and thermal stress-wave propagation; current thermomechanics problems in nuclear reactor design; term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

490. **Special Topics.** Selected areas are considered which are of current interest in research, such as nuclear materials, advanced reactor systems, thermonuclear problems, digital computer methods in nuclear engineering, advanced topics in reactor theory. ½ or 1 unit. Prerequisite: Consent of instructor.

495. **Nuclear Engineering Problems.** Individual study in areas of nuclear engineering and closely related fields not covered by regular course offerings. The work is carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: At least three units of graduate work; consent of instructor.

497. **Seminar in Nuclear Science and Engineering.** Lectures and discussions on current work in research and development in nuclear engineering and related fields by staff, advanced students, and visiting lecturers. 0 or ¼ unit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

347. **Introduction to Nuclear Engineering.** Nuclear particles and nuclear chain reactions, energy release from fission; classification of nuclear reactors; fast and thermal reactors; reactor theory; slowing down and diffusion of neutrons; radiation shielding; materials of construction, radiation damage; reactor instrumentation, safety, and control; chemical processing of nuclear materials. ¾ or 1 unit. Prerequisite: Physics 282 or 382 and senior standing in engineering, or consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Civil Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry; sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Nuclear Engineering 397 or Physics 382, or equivalent.

397. **Radiochemistry.** Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Chemistry 398. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. One laboratory and one discussion period per week. ½ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

PHILOSOPHY

The Department of Philosophy offers work leading to the Master of Arts and Doctor of Philosophy.

Students beginning graduate work with philosophy as their major subject are expected to have a grade-point average of at least 4.0 for the last sixty hours of work completed. Applications of students whose grade-point averages are below 4.0 but above 3.75 are considered on an individual basis, as are also all applications for entrance with advanced standing.

In addition, students applying for admission in philosophy should have had courses in logic, ethics, history of philosophy, and theory of knowledge. Students with deficiencies are required to take one or more of the following courses: Philosophy 102 (or 333), 321, 303, 306, or 330, in addition to meeting the minimum requirements of eight units for the master's degree.

Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic, philosophy of science, and philosophy of language; and theory of value, including ethics, aesthetics, social philosophy, and philosophy of religion. In addition to completing eight units of graduate work, the candidate must take an oral examination on the work represented by these units, including his master's thesis.

Doctor of Philosophy. A candidate carries on (1) major studies in one of three fields within the department; (2) minor studies amounting to at least two units in each of the two remaining fields; and (3) minor studies amounting to at least two units in a department other than philosophy. The candidate's choice of major and minors must be approved by the department.

The candidate must pass a preliminary examination, write a dissertation of publishable quality, and pass a final examination on the dissertation.

A detailed statement of the special departmental requirements for graduate students can be obtained from the Department of Philosophy, 105 Gregory Hall.

GRADUATE FACULTY

Professors: B. J. Diggs (Chairman of Department), A. H. Donagan, M. H. Fisch, L. Linsky, A. R. Turquette, F. L. Will.

Associate Professors: C. E. Caton, O. A. Kubitz, H. M. Tiebout.

Assistant Professors: H. S. Chandler, R. N. Faber, A. I. Fine, I. Mueller, R. J. Swartz, W. J. Wainwright, J. D. Wallace.

COURSES FOR GRADUATES

401. **Seminar in Ancient Philosophy.** 1 unit. May be repeated for credit. Fisch.

403. **Seminar in Medieval Philosophy.** 1 unit. Diggs.

405. **Seventeenth-Century Continental Thought (Descartes, Spinoza, Leibnitz).** A study of the basic philosophical works of the three leading continental thinkers of the century. 1 unit. Donagan.

407. **British Empiricism.** 1 unit. Turquette.

408. **German Idealism (Kant).** 1 unit.

409. **Recent American Philosophy.** Major American philosophers and movements since about 1900. Reports and discussions. 1 unit. FISCH.

411. **Seminar in Recent Ethical Theory.** 1 unit. May be repeated for a maximum of two units. DIGGS.

412. **Seminar in Social Philosophy.** A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. 1 unit. May be repeated for credit. DIGGS.

413. **Logical Theory.** 1 unit. Prerequisite. A course in logic or consent of instructor. TURQUETTE.

415. **Seminar in Metaphysics.** Intensive study of a selected topic of major importance in the field of metaphysics. 1 unit. May be repeated for credit. CATON, LINSKY.

417. **Philosophy and Methods of Science.** Various problems arising from specific studies in philosophy pertaining to science and vice versa; it is expected that each semester the members of the seminar will select one or two such topics. 1 unit. FINE.

420. **Seminar in Semantics.** Same as Communications 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. CATON, LINSKY.

421. **Seminar in Contemporary Problems.** Intensive study of selected problmes or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

422. **Seminar in Contemporary Problems.** Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

423. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit. WILL.

424. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit. WILL.

425. **Seminar in the Philosophy of Mind.** Selected topics from major writings in the philosophy of mind. 1 unit. May be repeated for credit.

430. **Seminar in Modern Aesthetics.** 1 unit.

439. **Seminar in the Philosophy of Mathematics.** Detailed examination of important questions arising from philosophical and logical analyses of mathematics. 1 unit. May be repeated for credit. Prerequisite: Consent of instructor.

483. **Individual Topics.** Individual study and oral written reports on topics not covered in other courses. Not more than one unit may be counted toward the A.M. degree and not more than two toward the Ph.D. degree. Topics and plan of study must be approved by the candidate's adviser and by the staff member who directs the work. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** 1 unit. FISCH.

304. **History of Medieval Philosophy.** Lectures and reading in the history of philosophy from St. Augustine to William of Ockham. ¾ or 1 unit. Prerequisite: Philosophy 101 or 303. DIGGS.

306. **History of Modern Philosophy.** 1 unit. DONAGAN.

307. **History of Modern Philosophy.** Bacon, Hobbes, Locke, Berkeley, Hume. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

308. **History of Modern Philosophy.** Descartes, Spinoza, Leibnitz, Kant. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

309. **The Philosophy of Plato.** ¾ or 1 unit. Prerequisite: Philosophy 101 or 303.

311. **Philosophic Ideas of the Nineteenth and Twentieth Centuries.** ¾ or 1 unit. TIEBOUT.

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. ¾ or 1 unit. Prerequisite: One course in philosophy. FISCH.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. ¾ or 1 unit. Prerequisite: One course in philosophy.

319. **Philosophical Ideas in Latin America.** A survey of the main philosophical currents and thinkers of Latin America. ½ or 1 unit. Prerequisite: One course in philosophy. KUBITZ.

321. **Ethics and Value Theory.** ¾ or 1 unit. Prerequisite: One course in philosophy. CATON, DIGGS.

322. **Recent Developments in Ethics.** Ethical theories of the last fifty years: intuitionism, naturalism, pragmatism, emotivism, existentialism, analytic ethics. ¾ or 1 unit. Prerequisite: Philosophy 103, 105, or 321.

323. **Philosophy of Art.** A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. ¾ or 1 unit.

324. **Philosophy of Religion.** ¾ or 1 unit. Prerequisite: One course in philosophy. WAINWRIGHT.

325. **Philosophy of Mind.** Philosophical problems arising in connection with mental phenomena; the relation of mind and body; free will and determinism; our knowledge of other minds; the self and personal identity. ¾ or 1 unit. Prerequisite: One course in philosophy.

326. **Metaphysics.** ¾ or 1 unit. Prerequisite: One course in philosophy.

327. **Scientific Method.** Methodology and epistemology; empirical knowledge and learning from experience; science and common sense; scientific explanation; historical examples; generalizing and historical science; natural and social science historicism; explanation in the social sciences. ¾ or 1 unit. FINE.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. ¾ or 1 unit. Prerequisite: One course in philosophy. FINE, TURQUETTE.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. ¾ or 1 unit. Prerequisite: One course in philosophy. CATON, LINSKY.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method, and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. ¾ or 1 unit. Prerequisite: One course in philosophy. CATON, LINSKY.

332. **Perception and Knowledge.** A systematic study of basic problems in the philosophy of perception: perceiving as a mental state; the objects of perception; sensing, sensation, and sense-data; perception and the external world; perception as the basis of empirical knowledge. Traditional empiricist philosophies of percep-

tion are examined and contemporary criticisms and defenses are assessed. ¾ or 1 unit. Prerequisite: One course in philosophy. SWARTZ.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. ¾ or 1 unit. TURQUETTE.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. ¾ or 1 unit. Prerequisite: Philosophy 333. TURQUETTE.

335. **Social Philosophy.** The nature of social organization as seen from economic, moral, and political standpoints; various senses of freedom; relations between organization and freedom; the free society. ¾ or 1 unit. Prerequisite: One course in philosophy.

336. **Philosophy of Law and of the State.** ¾ or 1 unit. Prerequisite: One course in philosophy.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth; study of the functions of language, definition, meaning and verification, semantical paradoxes. ¾ or 1 unit. Prerequisite: A course in logic. FABER, LINSKY.

338. **Philosophies of Language.** Same as Linguistics 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

339. **Philosophy of Mathematics.** Introduction to some of the main philosophical problems and contemporary viewpoints concerning mathematical concepts, mathematical methods, and the nature of mathematical truths. The concept of infinity; conventionalism and formalism; the distinction between analytic and synthetic truths; necessity; mathematics and the problem of universals; other related topics. ¾ or 1 unit. Prerequisite: One course in philosophy. MUELLER.

340. **The Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas,* taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

341. **Existentialism.** An introduction to contemporary philosophical existentialism. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. ¾ or 1 unit. Prerequisite: One course in philosophy.

361. **Comparative Religions: The Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

362. **Comparative Religions: The Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

PHYSICAL EDUCATION

The department offers programs of graduate study leading to the Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, including sport, dance, and exercise. The Doctor of Philosophy program also permits candidates to specialize in the areas of health education, safety education, and recreation. (See Health and Safety Education, page *183*, and Recreation and Municipal Administration, page *307*.)

Admission requirements for a major in the field are: (1) a minimum grade-point average of 4.0 for the last sixty hours of undergraduate study (applicants whose averages are below 4.0 but above 3.75 are considered on an individual basis); (2) thirty hours of approved credit in physical education or related fields; (3) eighteen hours of approved undergraduate credit in science; (4) sixteen hours of undergraduate credit in education; and (5) a course in statistics or measurement. Graduate Record Examination aptitude and achievement test scores, as well as a Miller Analogies Test score, should be submitted to the department.

Master of Science. Graduation requirements for this degree are eight units including (1) four units in physical education or approved related courses (health education or recreation); (2) two units in education including History and Philosophy of Education 303 and 304, and Educational Psychology 311 and 312; (3) Physical Education 490, one semester, no credit; (4) thesis, two units.

Candidates may petition to waive the thesis and seminar requirements but must take two additional units of credit and pass a final comprehensive written examination in physical education and related fields.

Doctor of Philosophy. Requirements for this degree are twenty-four units of credit including (1) a minimum of eight units in physical education courses or approved related courses in health education, safety education, or recreation; (2) one minor for a minimum of four units, or two minors for a minimum of two units each; (3) Physical Education 490; and (4) presentation of an acceptable thesis of eight units.

GRADUATE FACULTY

Professors: E. F. Zeigler (Head of Department), T. K. Cureton, Jr., A. W. Hubbard, Laura J. Huelster, H. E. Kenney, C. G. Knapp, K. J. McCristal.

Associate Professors: Charlotte L. Lambert, D. O Mathews, R. H. Pohndorf, R. E. Shelton, Olive G. Young.

Assistant Professors: A. W. Flath, R. E. Herron, W. Johnson, A. C. Moore, Jr., B. L. Rothermel, Marianna Trekell, H. J. VanderZwaag, E. J. Wright.

COURSES FOR GRADUATES

401. **Administration of Physical Education and Sport.** Analysis of completed research relating to theory and practice of administration in physical education and sport; the development of policy statements and procedures manuals for the various educational levels; experience in the use of the case plan of instruction as a teaching technique for the development of competencies and knowledges relating to human relations and administration in this specialized field. 1 unit. Prerequisite: Physical Education for Men (or Women) 204 or equivalent. Huelster, Matthews, Pohndorf, Zeigler.

402. **History of Physical Education and Sport.** An analysis of the research literature related to the historical foundations of physical education and sport; discussion of such persistent historical problems as the influence of economics, politics and

nationalism, curriculum and methods of instruction, professional preparation, the healthy body, dance, the use of leisure, and amateur and professional sport. 1 unit. Prerequisite: Physical Education for Men (or Women) 209 or equivalent. HUELSTER, MATTHEWS, POHNDORF, ZEIGLER.

406. **Philosophy of Physical Education and Sport.** Philosophical analysis of physical education and sport (with some reference to school health and recreation) in the light of the leading philosophical tendencies and possible implications for public and private education; analysis of completed research; includes delineation of one's personal philosophy and the use of philosophical analysis as a research technique. 1 unit. Prerequisite: Philosophy 101; History and Philosophy of Education 305. HUELSTER, VANDERZWAAG, ZEIGLER.

407. **Sport Psychology.** Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, perception and emotion in sport situations; review of literature; independent projects. 1 unit. Prerequisite: Psychology 100; Educational Psychology 211; consent of instructor. HUBBARD, YOUNG.

408. **Principles of Kinesiotherapy.** Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically prescribed clinical training; literature; research. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, and physiology of exercise, or consent of instructor. SHELTON.

450. **Trends and Techniques in Rehabilitation.** Philosophy of rehabilitation; education of the handicapped (blind and partially sighted, deaf and hard of hearing, mentally handicapped, socially maladjusted, crippled, cardiac, epileptic, speech deviate, etc.); state, federal, and community education and vocational training programs; literature; research. 1 unit. SHELTON.

451. **Scientific Foundations of Physical Fitness.** Scientific basis for physical fitness; analysis of fitness programs and fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. CURETON, POHNDORF, ROTHERMEL.

452. **Scientific Analysis of Physical Education Activities.** Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. CURETON.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. **Seminar.** Lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders; presentation and criticism of student theses. No credit. CURETON, POHNDORF, TREKELL, VANDERZWAAG, STAFF.

493. **Special Projects.** Independent research on special projects. Offered summers as special group practicums. ½ or 1 unit. STAFF, VISITING FACULTY.

495. **Techniques of Research in Health, Physical Education, and Recreation.** Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. 1 unit. HUBBARD, POHNDORF, TREKELL, VANDERZWAAG.

499. **Thesis Research.** Preparation of theses in physical education. 0 to 4 units. STAFF.

PHYSICAL SCIENCES

A special program leading to the Master of Science in the Physical Sciences is available to meet the needs of secondary school teachers who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit are acceptable toward the degree. To qualify for the degree, a student must present at least one course in mathematics beyond calculus, for which calculus is prerequisite. In addition, he must have met the requirements for teacher certification.

Candidates for the Master of Science in the Teaching of the Physical Sciences, which is distinct from the program described above, must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include two of the following courses: History and Philosophy of Education 302, 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The courses in the physical sciences and the electives—which must normally give graduate credit—must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 3.5.

Inquiries concerning these programs should be directed to Professor Don Secrest, 300a Noyes Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Physics.

There is opportunity for specialization in atomic and nuclear physics, including research with the betatrons, the clyclotron, and with radioactive sources; in nuclear magnetic resonance; in theoretical physics; in the physics of solids, including research on ionic crystals, metals, semiconductors, cryogenics, and surface physics; in plasma physics and aeronomy.

Requirements for admission to the Graduate College with a major in physics are twenty semester hours of physics, including Physics 321, 341, and 342, or the equivalent, and excluding courses in general physics, and an average of at least 3.75 for the last sixty hours of undergraduate work. Advanced undergraduate courses in light, thermodynamics, and atomic physics are strongly recommended.

The requirements for the Master of Science in Physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department.

Candidates for the Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Educational Psychology 311, 312, and one additional unit in education selected from History and Philosophy of Education 301, 302, 303, and 304. Students applying for admission must present an average of 3.75 for the last sixty hours of undergraduate work; applications of students with averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor G. M. Almy, 209 Physics Building.

For information concerning applied mathematics, see page 253; for information about biophysics, see pages 81 and 227. A doctoral program in chemical physics is described on page 91.

GRADUATE FACULTY

Professors: G. M. Almy (Head of Department), F. T. Adler, J. S. Allen, D. Alpert, G. Ascoli, P. Axel, J. Bardeen, F. C. Brown, R. M. Brown, W. D. Compton, L. D. Fosdick, H. Frauenfelder, J. J. Gilman, E. L. Goldwasser, A. V. Granato, R. Haag, P. Handler, A. O. Hanson, J. D. Jackson, L. P. Kadanoff, J. S. Koehler, L. J. Koester, P. G. Kruger, U. E. Kruse, L. S. Lavatelli, D. Lazarus, E. M. Lyman, D. E. Mapother, R. J. Maurer, B. H. McCormick, K. Nishijima, J. R. Pasta, D. Pines, D. G. Ravenhall, C. S. Robinson, G. A. Russell, C. T. Sah, R. D. Sard, C. B. Satterthwaite, R. O. Simmons, C. P. Slichter, J. H. Smith, J. N. Snyder, A. Wattenberg, J. C. Wheatley, H. W. Wyld, M. E. Wyman.

Associate Professors: A. Abashian, G. A. Baym, M. K. Brussel, J. H. Cahn, D. H. Cooper, C. P. Flynn, D. M. Ginsberg, J. P. Hummel, E. A. Jackson, F. W. Loomis, M. J. Raether, A. I. Yavin.

Assistant Professors: M. V. Klein, F. M. Propst, R. L. Schult, H. J. Stapleton, D. C. Sutton.

COURSES FOR GRADUATES

400. **Problems and Methods of Mathematical Physics.** Matrices and tensors; analytic functions of a complex variable; conformal mapping; contour integration; ordinary differential equations: solutions at singular points, contour integral solutions, asymptotic expansions; eigenfunctions and eigenvalues; partial differential equations: Laplace's equation, wave equation, diffusion equation, Green's functions; Legendre, Bessel, confluent hypergeometric Mathieu, and elliptic functions; elementary difference equations. 1 unit. Prerequisite: Mathematics 342 or 345 or 347 or 387; Physics 322 and 342; or consent of instructor.

422. **Dynamics and Nonlinear Mechanics.** Hamiltonian mechanics: Lagrange equations, Hamilton's canonical equations, contact transformations, Lagrange and Poincare invariants, Hamilton-Jacobi equation and Huygens' principle; perturbation theory, relaxation oscillations and stability of periodic motion, theory of cosmotron orbits, three-body problems. 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. **Relativity and Cosmology.** Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor.

435. **Theory of Semiconductors and Semiconductor Devices.** Same as Electrical Engineering 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

436. **Selected Topics in Physics of Solids.** The following topics are offered in rotation, one or two each semester.

(a) **Imperfections in Metals.** Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, on physical properties, on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) **Imperfections in Ionic Crystals.** Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the elec-

tronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.
(c) **Magnetic Properties of Solids.** Quantum theory of diamagnetism, paramagnetism, ferromagnetism; elements of magnetic resonance and relaxation. 1 unit. Prerequisite: Physics 482 and 490, or consent of instructor.

441. **Electrodynamics.** Electrostatics; Laplace's and Poisson's equations; boundary value problems; spherical harmonics; multiple potentials; dielectrics; microscopic and macrosopic fields; electric susceptibility; magnetostatics; magnetic multipoles; magnetic media; conducting media; Maxwell's equations; field energy and momentum; electromagnetic waves; reflection and refraction; dispersion; wave packets; causality; diffraction; wave guides and cavity resonators; simple aspects of magnetohydrodynamics and plasmas. 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. **Electrodynamics.** Special theory of relativity; covariant formulation of electrodynamics; charged particle dynamics; high energy particle accelerators; energy loss by charged particles traversing matter; multiple scattering; Lienard-Wiechert potentials; radiation by charged particles; radiation loss in particle accelerators; Thomson scattering; bremsstrahlung; Weiszacker-Williams method; inner bremsstrahlung; Cerenkov radiation; radiative reaction; natural line breadth; multiple expansion of radiation field; Lagrangian and Hamiltonian formulation of electrodynamics. 1 unit. Prerequisite: Physics 441.

455. **Reactor Physics, I.** Same as Nuclear Engineering 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections, diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

456. **Reactor Physics, II.** Same as Nuclear Engineering 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Physics 455 or consent of instructor.

462. **Statistical Mechanics and Kinetic Theory.** Single-particle distribution functions: classical and quantum mechanical systems, Boltzmann equation, virial theorem, equations of state for gases; formal theory: ensembles, identical particles, thermodynamics of simple systems, distribution functions; non-equilibrium problems: conservation laws and hydrodynamics equations, sound waves, transport coefficients; plasmas, normal Fermi fluid, superfluids, systems with internal degrees of freedom. 1 unit. Prerequisite: Physics 360 and elementary quantum mechanics, or consent of instructor.

463. **Low Temperature Theory and Quantum Liquids.** Normal Fermi liquids: equilibrium properties, transport equation, quasi-particle collisions, degenerate He^3, Landau theory; formal description of experimental measurements in neutral and charged Fermi liquids; superfluid Bose liquid: He II, rotating buckets, macroscopic description of superfluid flow, two-fluid model, first, second, and quasi-particle sound, vortex lines, microscopic theory; superconductivity: BCS theory, electrodynamics and coherence effects, superconductivity in metals, tunnel effect, flux quantization, microscopic theory of superfluid flow, vortices. 1 unit. Prerequisite: Physics 362 or 462, and 481, or consent of instructor.

465. **Plasma Physics.** Basic equations of magnetohydrodynamics; orbit theory; stability of plasma configurations; hydromagnetic waves; plasma oscillations; high-frequency instabilities; spontaneous fluctuation theory; Fokker-Planck equation; transport processes; oscillations in a magnetic field; interaction of electromagnetic waves with plasmas. 1 unit. Prerequisite: Physics 362 and 441, or Electrical Engineering 423, or consent of instructor.

467. **Atomic Collision Processes.** Same as Electrical Engineering 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photoprocesses and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

470. **Introduction to Nuclear and Particle Physics.** Basic facts of photons, leptons, hadrons, conservation laws, types of interaction, particle production and stability symmetries, nuclear forces, and ground state properties; two-particle systems: electromagnetic interactions, bound states, and resonances; nucleon-nucleon and meson-nucleon interactions; nuclei: properties of low-lying states, models, resonant reactions, and direct processes; particles and weak interactions: multi-pion resonances, symmetry schemes, beta decay and other leptonic processes, strange particle decays. 1 unit. Prerequisite: Concurrent registration in Physics 482.

471. **Nuclear Physics, I.** Systematics of stable nuclei and the nuclear potential; properties of odd-A nuclei; spherical single particle shell model; residual interactions; collective states and deformed nuclei; summary of theory and experiment for low-lying states; momentum distribution of nucleons; fission. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

472. **Nuclear Physics, II.** Resonance reactions: fast and slow neutron cross sections, neutron and gamma widths, strength functions, giant dipole resonance, compound nucleus, and statistical model; direct reactions: optical model, elastic and inelastic scattering, polarization, angular correlations; spectroscopic factors, intermediate structure, isobaric analogs. 1 unit. Prerequisite: Physics 471.

475. **Particle Physics, I.** Particles: properties and systematics; S-matrix theory; application of symmetry and invariance principles to decays, production processes and polarization; collision processes; mesonic and baryonic resonances; symmetry schemes; particle scattering at very high energies; theory of pion-nucleon scattering, dispersion relations, Mandelstam representation. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

476. **Particle Physics, II.** Electromagnetic interactions of particles, form factor, predictions of unitary symmetry; beta and muon decay and capture, conserved and partially conserved currents, neutrino interactions, weak interaction form factors; leptonic and non-leptonic decays of strange particles; neutral K-meson decays; current topics. 1 unit. Prerequisite: Physics 475.

480. **Quantum Mechanics, I.** Introduction to concepts of quantum theory, with applications. Review of classical Lagrangian mechanics; historical review of quantum phenomena, Bohr theory, and the wave nature of matter; Schrödinger wave equation; one-dimensional potential well and barrier penetration problems; three-dimensional problems, angular momentum, hydrogen atom; simple stationary state perturbation theory, perturbation of energy levels, Stark effect, normal Zeeman effect. 1 unit. Prerequisite: Physics 322 and 342; a course in atomic physics.

481. **Quantum Mechanics, II.** Principally applications to atomic and molecular structure. Electron spin; spin-orbit coupling, anomalous Zeeman effect; semiclassical treatment of emission and absorption of radiation with examples; selection rules, atomic spectra, x-ray spectra; Pauli principle, helium atom, exchange energy; periodic system of elements, Fermi-Thomas atom; diatomic molecules, electronic motion, vibrational and rotational motion, band spectra; simple collision problems, partial wave analysis. Born approximation. 1 unit. Prerequisite: Physics 480 or consent of instructor.

482. **Quantum Mechanics, III.** Formal structure of quantum theory; quantum theory of angular momentum, vector addition coefficients, simple tensor operators; collision problems, inelastic scattering, formal scattering theory; elementary treat-

ment of quantization of the radiation field and the interaction of light with matter; introduction to Dirac electron theory. 1 unit. Prerequisite: Physics 481 and 422, or consent of instructor.

487. **Topics in Advanced Quantum Theory.** The following topics are offered alternately, but not every year.

(a) **Advanced Quantum Mechanics.** Relativistic quantum mechanics of a single particle; Dirac equation, Lorentz transformation, properties and bilinear covariants, bound state and scattering problems, Möller and Breit interactions, elementary radiation theory, relativistic photoeffect, bremsstrahlung, formal scattering theory. S-matrix, symmetry principles. 1 unit. Prerequisite: Physics 482.

(b) **Quantum Field Theory.** Field quantization; scalar and pseudoscalar meson field: electromagnetic field, Dirac field, interacting fields, electrodynamics; meson theory; interaction representation; S-matrix; covariant perturbation theory and Feynman diagrams; Compton scattering; Möller scattering; bremsstrahlung; pair annihilation; charge and mass renormalization; Lamb shift; anomalous electron magnetic moment; Heisenberg representation; dispersion relations; recent developments. 1 unit. Prerequisite: Physics 487a.

489. **Solid State Physics, I.** Introduction to the modern theory of crystalline materials. Topics treated include crystal symmetry, elastic and thermal properties of solids, optical properties, point defects and imperfections in crystals. 1 unit. Prerequisite: Physics 360, 362, 381, 480, or consent of instructor.

490. **Solid State Physics, II.** Introduction to band theory of solids, free electron model, electrons in periodic potential, cohesion, transport properties of metals and semiconductors, experimental methods for determining band structure. 1 unit. Prerequisite: Physics 481, 489, or consent of instructor.

491. **Solid State Physics, III.** Elementary excitations in solids; phonons, electrons, plasmons, excitons, spin waves, treated as elementary excitations in interaction with one another and with external fields and particles. 1 unit. Prerequisite: Physics 481.

497. **Individual Study.** Individual study in a subject not covered in course offerings may be arranged for credit by registration under this number. ½ or 1 unit.

498. **Special Topics in Modern Physics.** Seminar. Lecture courses in topics of current interest are given under this number. Subjects are announced in the Time Table. ½ or 1 unit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Modern Experimental Physics, I.** Techniques and experiments in the physics of atoms, atomic nuclei, molecules, the solid state, and other areas of modern physical research. 1 unit. Prerequisite: Physics 342; concurrent registration in Physics 381.

304. **Modern Experimental Physics, II.** Continuation of Physics 303. 1 unit. Prerequisite: Physics 303.

321. **Theoretical Mechanics.** Motion of a particle in one, two, and three dimensions with applications; Kepler's laws and planetary motion; scattering of particles; conservation laws; motion of a rigid body in two dimensions; statics of extended systems. Lectures and problems. 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics; registration in Mathematics 341, 345, or 349.

322. **Theoretical Mechanics.** Continuation of Physics 321. Moving coordinate frames, fictitious forces; special theory of relativity, conservation laws, particle motion and creation; rigid body motion in three dimensions; gravitation and earth motion; generalized coordinates and Lagrange's equations; constraints, small vibrations. 1 unit. Prerequisite: Physics 321.

341. **Electricity and Magnetism.** The fundamental laws are introduced using the vector notation stressing Maxwell's equations in the integral form. Topics covered with applications and problems include direct current circuits, circuit theorems, electric and magnetic fields, Gauss's Law, capacitance and inductance; energy and forces associated with these fields in free space and in matter. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. ½ or 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics; credit or registration in Mathematics 341, 343, or 345, or consent of instructor.

342. **Electricity and Magnetism.** Continuation of Physics 341. Effects associated with changing fields and currents, Faraday's Law, displacement current, transient currents, complex variables in circuit analysis, coupled circuits, and circuit theorems; an introduction to the generation and propagation of electromagnetic waves and the wave equations. ½ or 1 unit. No credit is given to graduate physics majors. Prerequisite: Physics 341.

343. **Electronic Circuits.** The physics of vacuum tube and semiconductor devices; theory and application of these devices as linear circuit elements in power supplies, amplifiers, communication circuits and control circuits. Emphasis is on experimental techniques. Lectures, problems, and laboratory. 1 unit. Prerequisite: Physics 341 or consent of instructor.

344. **Electronic Circuits.** Continuation of Physics 343. Electronic instruments and techniques used in research in physics and digital computers; theory and experiments emphasizing the use and design of nonlinear circuits, e.g., multivibrators, pulse generators, counters, etc.; theory of switching circuits; special topics. 1 unit. Prerequisite: Physics 343 or equivalent.

347. **Electromagnetic Theory and Boundary Value Problems.** Beginning with Maxwell's equations, this course treats electrostatic and magnetostatic boundary value problems and multipole expansions with orthogonal polynomials, boundary value problems in quasistatic and radiation fields, simple radiating systems, and scattering of scalar waves. 1 unit. Prerequisite: Mathematics 343 and 345, Physics 342 or Electrical Engineering 229; or consent of instructor.

360. **Thermodynamics.** Zeroth, first, second, and third laws of thermodynamics; applications to simple physical and chemical systems; thermodynamics inequalities and equilibrium; phase transitions. Lectures and problems. 1 unit. Prerequisite: General physics and calculus; senior standing in physics is advised.

362. **Kinetic Theory and Statistics.** A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose, Einstein, and Fermi-Dirac statistics and applications. 1 unit. Prerequisite: Physics 360 or consent of instructor.

366. **Aeronomy: Physics of the Upper Atmosphere and Space.** Same as Astronomy and Electrical Engineering 366. Structure and composition of the earth's upper atmosphere; solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

371. **Light.** Wave optics: description and superposition of waves, coherence, interference, diffraction, polarization, and dispersion. Geometrical optics: image formation, optical systems, thick lens theory, image defects; applications to optical instruments. Lectures, problems, and laboratory. ½ to 1 unit. Prerequisite: General physics; Mathematics 345 or consent of instructor.

381. **Atomic Physics.** Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics covered include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345; concurrent registration in Physics 385 is recommended.

382. **Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. 1 unit. Prerequisite: Physics 381 or 383.

383. **Atomic Physics and Quantum Theory for Engineers.** Introduction to the basic concepts of quantum theory which underlie modern theories of the properties of materials. Topics covered include elements of atomic and nuclear theory, kinetic theory and statistical mechanics, quantum theory, and simple applications, atomic spectra and atomic structure, molecular structure and chemical binding. Lectures and problems. ¾ or 1 unit. Prerequisite: General physics; general chemistry; Mathematics 345 or equivalent.

385. **Introduction to Quantum Mechanics.** Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. 1 unit. Prerequisite: Mathematics 343, Mathematics 345, or consent of instructor; registration in Physics 381 is recommended.

PHYSIOLOGY AND BIOPHYSICS

See descriptions and course listings under Life Sciences, page 226.

PLANT PATHOLOGY

Graduate work leading to the Master of Science and Doctor of Philosophy is available in the Department of Plant Pathology. Students may choose a major, joint major, or minor in plant pathology. The following fields are available for specialization: diseases of field crops, forest and shade trees, fruit crops, ornamentals, turf and lawn grasses, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science must meet the general requirements of the Graduate College, present an acceptable thesis, and pass an oral examination before a committee of staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students are accepted with a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.49 are considered on an individual basis.

GRADUATE FACULTY

Professors: W. M. Bever (Head of Department), L. M. Black, J. C. Carter, J. W. Gerdemann, D. Gottlieb, A. L. Hooker, M. B. Linn, D. Powell, M. C. Shurtleff, H. H. Thornberry.

Associate Professors: M. P. Britton, D. P. Taylor.

Assistant Professors: D. W. Chamberlain, J. D. Paxton, P. D. Shaw.

COURSES FOR GRADUATES

401. Diseases of Forest and Shade Trees. A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. Offered in 1966-1967 and in alternate years. ½ or 1 unit. Prerequisite: Plant Pathology 301 or consent of instructor. Carter.

403. Physiology of Fungi. Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Organic chemistry or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

404. Plant Virology. Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, staining, assay, filtration, and purification; control methods; sources of information; history of virology. ½ or 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Consent of instructor. Thornberry.

417. Discussions in Plant Pathology. Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. ¼ unit. Staff.

499. Thesis Research. Individual study and research required of all students working toward the Master of Science or Doctor of Philosophy in Plant Pathology. 0 to 4 units. Work can be taken in the following areas, subject to approval of the staff member concerned:

(a) ***Biochemistry of Plant Disease.** Staff.

(b) ***Diseases of Corn; Genetics of Resistance.** Hooker.

(c) ***Diseases of Cereal Grains.** Bever, Hooker, Shurtleff.

(d) ***Diseases of Forest and Shade Trees.** Carter.

(e) ***Diseases of Fruit Crops; Fungicides.** Powell.

(f) ***Diseases of Leguminous Crops; Root Diseases.** Gerdemann.

(g) ***Diseases of Turf and Lawn Grasses.** Britton.

(h) ***Diseases of Soybeans.** Chamberlain.

(i) ***Diseases of Vegetable and Canning Crops.** Linn, Shurtleff.

(j) ***Nematode Diseases.** Taylor.

(k) ***Physiology of Fungi; Antibiotics.** Gottlieb, Shaw.

(l) ***Plant Virology.** Black, Thornberry.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. For students desiring to study specific problems not assigned in other courses. ¼ to 1 unit; maximum accumulated credit, two units. Staff.

301. Plant Pathology. Same as Botany 301. An introduction to plant pathology. Basic concepts of diagnosis, cause, and control are illustrated by study of selected plant diseases. 1 unit. Prerequisite: One year of plant science, including Botany 100. Bever, Staff.

302. **Research Methods in Plant Pathology.** Techniques for the isolation, identification, culture of, and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. ¾ unit. Prerequisite: Plant Pathology 204 or 301. PAXTON.

303. **Plant Nematology.** Experimental techniques, nematode anatomy, taxonomy, biology, and host-parasite relations; intensive study of selected groups including foliar, stem, root-knot, and cyst nematodes; interaction with bacteria, fungi, and viruses in plant disease development; control principles. ¾ unit. Offered in 1966-1967 and in alternate years. Prerequisite: Plant Pathology 204 or 301 and Zoology 104, or equivalent. TAYLOR.

304. **Forest Tree Diseases and Wood Deterioration.** Symptoms, causal agents, and control of the major forest tree diseases; causes and control of wood deterioration. ¾ unit. GERDEMANN.

305. **Principles of Plant Disease Control.** A study of the basic concepts of both nonchemical and chemical methods used for the control of plant diseases. Lectures, discussions, and assigned reading. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Plant Pathology 204 or 301; Chemistry 132 or 133; or consent of instructor. POWELL.

306. **Epiphytology and Diagnosis of Plant Diseases.** Detailed consideration of factors influencing the incidence and severity of diseases caused by fungi, bacteria, viruses, and nematodes; ecological factors as etiological agents, and techniques for determining the intensity of epiphytotics; plant disease identification. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Plant Pathology 204 or 301. BRITTON.

377. **Diseases of Field Crops.** Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Plant Pathology 204 or 301. HOOKER.

POLITICAL SCIENCE

The Department of Political Science offers work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, political behavior, political theory and jurisprudence.

Admission to graduate work in political science requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. The student must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history).

The department also administers a program leading to the Master of Arts in Public Administration. A grade-point average of at least 3.75 and a study proposal leading to a well-defined career or professional objective, approved by the department, are required for admission. The program is offered both in Urbana and through extramural classes in Springfield, and is matched to the individual needs and objectives of students. Programs for students without public service employment usually incorporate an internship of at least three months. Further details may be obtained from the department, 325 Lincoln Hall.

Graduate students in other departments who choose political science as a minor must have had at least six hours of undergraduate work in political science and three hours in other social sciences.

GRADUATE FACULTY

Professors: V. A. Thompson (Head of Department), R. Dangerfield, N. F. Garvey, S. K. Gove, C. B. Hagan, E. G. Lewis, P. Monypenny, R. E. Scott, C. F. Snider, G. Y. Steiner, F. G. Wilson.

Associate Professors: T. J. Anton, M. Davis, G. W. Fisher, G. Manner, S. S. Nagel, T. Page, D. G. Sullivan, G. T. Yu.

Assistant Professors: B. Glad, J. F. Hough, D. Kramer, W. E. Steslicke, M. G. Weinbaum.

Visiting Lecturers: M. Hobbs, L. G. Stauber.

COURSES FOR GRADUATES

400. Classics of Political Science. Reading, analysis, and discussion of leading works on politics and government. 1 unit. Staff.

401. History of Political Theories. Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. 1 unit. Wilson.

402. History of Political Theories. Reading and analysis of the leading political thinkers from the middle of the seventeenth century to the present. 1 unit. Wilson.

406. Municipal Administration. Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. 1 unit. Anton.

410. Problems in Rural Local Government. Research in selected topics. 1 unit. Snider.

412. Problems in State Government. Research in selected topics in American state government. 1 unit. Snider.

420. Formation of Public Policy. Same as Labor and Industrial Relations 420. An examination of the institutiontal and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, judicial activity. 1 unit Hagan.

421. Government and the Economic Order. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. 1 unit. Hagan.

425. Personality and Political Process. Rationality and its limits in political processes: the functions of symbols and myth in politics; political involvement and quiescence; nonrational elements in legislation and administration. 1 unit. Prerequisite: Consent of instructor. Edelman.

426. Political Parties. Special problems in political parties; methods and materials of research in this field. 1 unit.

427. Psychological Base of Political Behavior. This course is intended to introduce the student to relations between psychological mechanisms and life history factors and individual or group political behavior. Topics covered include national loyalty and ideology, mass public and political involvement, political authority, and individual compliance. 1 unit.

431. Problems of British Government. Special topics relating to British government. 1 unit. Lewis.

435. Problems in the Government of Soviet Russia. Special topics relating to the government of the Soviet Union. 1 unit. Hough.

440. Comparative Politics and the Political Process. The comparative study of selected national political systems or of specific institutional forces that influence the making and application of public policy in several countries. The countries studied and the legal and extra-legal political agencies considered vary accord-

ing to the person conducting the seminar. 1 unit. Course may be repeated for credit not to exceed a total of three units. STAFF.

441. **Politics in the Developing States.** An examination of the political processes in the developing countries. The general problems arising in the transition from traditional societies to modern industrial states are examined to describe the typical patterns of political change. Special attention is given to contemporary literature and studies. 1 unit. Prerequisite: Consent of instructor. SCOTT.

442. **Problems of Latin-American Politics and Government.** Special topics relating to Latin-American politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. 1 unit. Course may be repeated for credit not to exceed a total of two units. Prerequisite: Political Science 441 or equivalent. SCOTT.

447. **Problems of Asian Politics and Government.** Special topics relating to Asian politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. 1 unit. Course may be repeated for credit not to exceed a total of three units. Prerequisite: Political Science 441 or equivalent.

450. **Contemporary Governmental Problems.** Special problems of current importance. Designed especially for students not majoring in political science. S; 1 unit. Course may be repeated for credit not to exceed a total of three units. STAFF.

451. **Constitutional Law.** Research in selected topics in the American constitutional system. 1 unit. Prerequisite: Political Science 351 or equivalent. NAGEL.

465. **Problems in Administrative Management.** An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

466. **Current Administrative Theory.** A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision-making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. 1 unit. MONYPENNY.

471. **Problems in International Organization.** Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. 1 unit.

481. **Foreign Relations of the United States.** Special problems in the development and conduct of American foreign policy. 1 unit. DANGERFIELD.

484. **International Relations.** An analysis of the approaches and methods used in the study of international relations; the characteristics of states and of international systems; the problem of conflict and its resolution. 1 unit. JENSEN.

485. **International Law.** Research on selected topics. 1 unit. MANNER.

490. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit.

491. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict

and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit. Prerequisite: Political Science 490.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. ½ to 3 units. STAFF.

495. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; the present state of research in political science. 1 unit. HAGEN, MONYPENNY.

496. **Political Concepts—Formulation and Measurement.** The course is designed to indicate the relevance of certain research techniques for answering questions of concern in political science and to indicate the range of tools available to the student. Problems in concept formation are discussed. Current methods of concept measurement are presented to the student in the context of political research problems. 1 unit. Prerequisite: Consent of instructor.

497. **Research Design and Techniques.** This course is intended to introduce the student to problems of research design, data collection, data analysis and interpretation, sampling, and some simple measures of statistical association and significance. 1 unit. Prerequisite: Political Science 496.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. ½ or 1 unit. STEINER.

306. **Municipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. ½ or 1 unit. Prerequisite: Political Science 305, or Economics 102 and 103, or six hours of political science.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. ½ or 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; reorganization problems in the state; state-local relations; state finance; trends and prospects. Students do not receive credit for both Political Science 110 and 312. ½ or 1 unit. Prerequisite: Political Science 150 or 151. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reogranization. ½ or 1 unit. Prerequisite: Six hours of political science. HAGAN.

317. **The American Federal System.** The nature, justification, and problems of federalism; coordination of governmental efforts by contract, subsidies, and grants; comparison of federal systems. ½ or 1 unit. Prerequisite: Political Science 150 or 191. FISHER, STEINER.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. ½ or 1 unit. Prerequisite: Two courses in political science or in political science and economics. EDELMAN, HAGAN.

326. **American Political Parties.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor.

328. **Introduction to the Study of Political Behavior.** An analysis of the interrelations of political attitudes and public policy formation. Special attention is given to the substantive areas of voting behavior, political leadership, and the rise of political mass movements. The course also includes a review of the literature on democratic and authoritarian personality types. ½ or 1 unit. Prerequisite: Political Science 150 or equivalent. SULLIVAN.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. ½ or 1 unit. LEWIS, STESLICKE.

335. **Government and Politics of the Soviet Union.** Evolution, structure, and functioning of the Soviet system of government; the theories, structure, and functioning of the Communist party of the Soviet Union. ½ or 1 unit. HOUGH.

336. **Governments and Politics in Western Continental Europe.** An analysis of the major governmental systems of Continental Europe; the evolution, structure, and functioning of the political institutions of France, Germany, Italy, Spain, Switzerland, and the Scandinavian countries as illustrations of multiparty and dictatorial types of governments. ½ or 1 unit. LEWIS.

337. **Government and Politics of China.** An introduction to the governments and politics of modern China. ½ or 1 unit. Prerequisite: Six hours of political science.

338. **Governments and Politics in the Middle East.** An analysis of the transformation of Middle Eastern society from Morocco to Iran as case studies in political modernization. The politics of the area is studied with special reference to causes and character of modernization, role of leadership, ideologies, and institutions; methods and theories for analyzing political systems undergoing fundamental transformation, and implications for United States policy. ½ or 1 unit. Prerequisite: Six hours of political science.

339. **Governments and Politics in Sub-Saharan Africa.** Analysis of major political systems in Africa south of the Sahara. Emphasis on the development of states and the modification of social and political systems. A general survey of the area is supplemented by a focus on selected countries. ½ to 1 unit. Prerequisite: Six hours of political science.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. ½ or 1 unit. Prerequisite: Six hours of political science. SCOTT.

343. **Political Systems and Structures of Latin-American Countries.** The political process, generally of selected Latin-American countries at different levels of political development, with stress on the interaction between political infrastructure and more formal agencies of government. May include cross-national comparison of the function of such factors as political culture, party system, bureaucracy, or the military establishment. ½ or 1 unit. Prerequisite: Political Science 342. SCOTT.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

346. **Theory and Practice of Communism.** A survey of the international Communist movement; the origins of modern communism and the nineteenth-century development of its doctrines; the Russian Revolution; Lenin and Stalin, the U.S.S.R. as a model for communism; the regional development of Communist parties. ½ or 1 unit. KRAMER, WILSON.

347. **Governments and Politics of Southeast Asia.** A comparative analysis of the political development of the countries of Southeast Asia, the lands to the east of India and south of China, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

348. **Government and Politics of Japan.** An introduction to the government and politics of modern Japan. ½ or 1 unit. Prerequisite: Six hours of political science.

349. **Governments and Politics of South Asia.** A comparative analysis of the political development of India, Pakistan, Ceylon, and the lesser lands of South Asia, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. ½ or 1 unit. Prerequisite: Political Science 150 or 191. KRAMER, NAGEL.

355. **The Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. ½ or 1 unit. Prerequisite: Political Science 150 or 191. KRAMER, NAGEL.

356. **Public Administration and the Judicial Process.** The scope of administrative powers and their relation to private rights. A comparison of the processes of decision in administrative agencies and in the courts; the interests served by each; the impact of judicial review of administrative decisions upon administrative procedure and policy; the constitutional and statutory bases of review; the legal accountability of public officers versus political accountability. ½ or 1 unit. Prerequisite: Political Science 305 or 351, or consent of instructor. NAGEL.

357. **The Process of Law Enforcement.** Problems in the procedure of law enforcement including the nature and ramification of crime; the nature and sources of law; character and types of criminal law; structure of the court system and its role in criminal enforcement; agencies of law enforcement—federal, state, and local; interstate crime control; the police and crime detection; prosecution of criminal offenses; problems of judicial procedure; and correctional procedures. ½ unit. Prerequisite: Political Science 150 or 151. GARVEY.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MONYPENNY, PAGE.

362. **Administrative Organization and Policy Development.** Dynamics of policy formulation in public administrative agencies; current developments in organizational theory and their significance for public administration; origin of public administrative organizations; interpersonal behavior; large-scale organizations and centralization; external support and opposition; policy formation and problems of compliance. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

365. **Government and Labor.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

366. **Tools of Public Management.** A critical survey of the tools of analysis available to overhead functions of public management in key areas of decision; emphasis on personnel administration and manpower utilization, budgetary processes and fiscal controls, and several methods of administrative analysis—organizational studies, procedures engineering, information processing, and operations research. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

371. **World International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the United Nations and related agencies and to their evolution from the League of Nations system. ½ or 1 unit.

372. **Regional International Organizations.** Descriptive and comparative analysis of various regional international organizations, their role in contemporary politics and their relationship to the United Nations system; structure, functions, and accomplishments of North Atlantic Treaty Organization, Southeast Asia Treaty Organization, Organization of American States, and other regional international organizations. ½ or 1 unit. STESLICKE.

380. **Comparative Foreign Policies.** An analysis of the formulation and substance of the foreign policies of select nations of the world. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. ½ or 1 unit. Prerequisite: Six hours of political science. GLAD.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. ½ or 1 unit. Prerequisite: Political Science 381 or consent of instructor. DANGERFIELD, GLAD.

383. **Soviet Foreign Policy.** A survey of Soviet foreign policy from 1917 to the present, with emphasis upon the forces shaping this policy. Special attention is given to the interplay of ideology and national interest in policy formulation. ½ or 1 unit. HOUGH.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. ½ or 1 unit. MANNER.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. ½ or 1 unit. MANNER.

387. **National Security Policy.** An examination of the organization and formulation of current American defense policy; the theory of deterrence, with special reference to American and Soviet military strategy; the problems of disarmament and arms control. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

390. **Methods of Political Analysis.** Presentation of the analytic processes in the development of concepts, hypotheses, and theories. Discussion of the derivation, formulation, and specification of research problems to be related to basic methodologies and modes of analysis. Applications to political science. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of

Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation, and the Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. ½ or 1 unit. WILSON.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; antidemocratic thought and totalitarian regimes. ½ or 1 unit.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. ½ or 1 unit. Offered in 1967-1968 and in alternate years. WILSON.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the Master of Arts and Doctor of Philosophy.

Fields. Doctoral programs are offered in the following special areas of psychology: general experimental psychology, personality, social psychology, psychological measurement, clinical and counseling psychology, industrial psychology, school psychology, child psychology, psycholinguistics.

Admission. The candidate must meet the following departmental requirements: (1) a minimum of fifteen semester hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of at least 4.0. Preference is given to students who have taken college mathematics and two years of French, Russian, or German. It is not possible, however, to accept all applicants who meet the minimal requirements.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The Master of Arts is awarded to candidates who complete satisfactorily eight units of course work and present an acceptable thesis. The doctoral candidate must also complete an approved program of courses in his area of specialization.

In the fields of clinical and counseling psychology, and school psychology, the doctoral candidate must also complete the equivalent of a full-time academic year of internship in an agency approved by the Department of Psychology.

The Department of Psychology also offers a Master of Science degree in applied psychology to those students who have completed an undergraduate major in applied psychology at the University of Illinois. Students with a 3.5 average or higher may apply.

TRAINEESHIPS

United States Public Health Service Traineeships in Measurement and Clinical Psychology. Graduate students, including first-year applicants, are automatically considered for these appointments. No application is necessary. Current stipends (tax-free) are: Level I, $1,800; Level II, $2,000; Level III, $2,400; Level IV, $3,000. The trainee has no duties other than full-time graduate work.

Veterans Administration Traineeships in Clinical and in Counseling Psychology. First-year students are not eligible for these appointments. Applicants for advanced standing may apply for a traineeship by a letter addressed to the head of the Department of Psychology. The trainee works approximately half-time in a Veterans Administration hospital as a Civil Service appointee.

GRADUATE FACULTY

Professors: L. G. Humphreys (Head of Department), J. A. Adams, W. C. Becker, S. W. Bijou, R. B. Cattell, F. Costin, D. E. Dulany, C. W. Eriksen, T. N. Ewing, F. E. Fiedler, W. M. Gilbert, G. R. Grice, H. W. Hake, R. Hamlin, J. Hirsch, J. McV. Hunt, W. E. Kappauf, S. A. Kirk, L. H. Lanier, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, D. R. Peterson, I. D. Steiner, L. M. Stolurow, M. M. Tatsuoka, G. J. Thomas, L. R. Tucker.

Associate Professors: J. B. Cohen, M. E. Fishbein, H. L. Jacobs, Alice K. Jonietz, J. E. McGrath, H. C. Quay, K. E. Renner, D. T. Shannon, H. C. Triandis, Leigh M. Triandis, L. P. Ullmann, M. Wagman, M. W. Weir, J. S. Wiggins.

Assistant Professors: L. C. Ate, N. H. Eisen, Angela Folsom, G. Z. Greenberg, K. T. Hill, C. L. Hulin, L. A. Jakobovits, W. E. Montague, S. M. Nealey, G. L. Paul, R. J. Rose, K. G. Scott, R. L. Sprague, J. S. Werry, A. E. Whimbey.

COURSES FOR GRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all the prerequisites.

402. Systematic Psychology. A critical analysis and comparison of modern and contemporary psychological systems. 1 unit. Prerequisite: Twelve hours of psychology. Dulany.

403. Proseminar in General Psychology, I. A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. 1 unit. Prerequisite: Twelve hours of psychology. Peterson, Staff.

404. Proseminar in General Psychology, II. Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. 1 unit. Prerequisite: Twelve hours of psychology. Kappauf, Staff.

408. Design of Experiments in Psychology. Advanced experimental designs in psychological research; special methods of data analysis. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Psychology 307. Kappauf.

409. Psychological Scaling. Same as Sociology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Psychology 307. Tucker.

411. Advanced Physiological Psychology. Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation, learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. O'Kelly.

415. Experimental Sensory Psychology. A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. Kappauf.

416. Perception. Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpretations. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Twelve hours of psychology. Hake.

417. **Experimental Psychology of Learning, I: Basic Processes.** A study of experimental investigation of basic learning processes, with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. 1 unit. Prerequisite: Twelve hours of psychology. GRICE.

418. **Experimental Psychology of Learning, II: Human Learning.** Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. 1 unit. Prerequisite: Psychology 417 or consent of instructor. ADAMS.

419. **Advanced Comparative Psychology.** A critical survey of techniques, results, and problems in the study of animal behavior and human behavior from the comparative-evolutionary point of view. Laboratory demonstrations and individual research problems. 1 unit. Prerequisite: Twelve hours of psychology or biology. HIRSCH.

421. **Problems in Motivation.** 1 unit. Prerequisite: Twelve hours of psychology. O'KELLY.

425. **Psycholinguistics.** Same as Communications and Linguistics 425. A critical survey of methods and theories in the psychological study of the communication process, with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Communications and Linguistics 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Psychology 425; consent of instructor. MACLAY, OSGOOD.

427. **Engineering Psychology.** Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent. HAKE.

428. **Higher Process.** An examination of method, theory, and research in the study of thinking; status of cognition as a construct; verbal control of behavior; concepts, problem solving, attention, language and thought; cognitive process: as a source of motivation. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. DULANY.

431. **Psychological Measurement in Industry.** Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. 1 unit. Prerequisite: Psychology 307 or equivalent. HULIN.

435. **Motivation and Morale in Industry.** Same as Labor and Industrial Relations 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. H. C. TRIANDIS.

441. **Personality and Behavior Dynamics.** The cross-sectional structure of personality, the basic principles of behavior dynamics and the determinants which shape personality development are described. Special topics include typologies, trait measurement, conflict and anxiety, and mechanisms of defense. ½ unit. Prerequisite: Twelve hours of psychology. WIGGINS.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. ½ unit. Prerequisite: Psychology 338; consent of instructor.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and

achievement. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 290 or equivalent. W. C. Becker, Shannon.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. 1 unit. Prerequisite: Psychology 443; consent of instructor. W. C. Becker, Shannon, Wiggins.

445. **Behavior Modification.** A critical survey of issues, principles, practice, and research related to modifying human behavior. The course covers psychotherapeutic and somatic approaches; symptomatic relief and personality-restructuring goal-orientations; individual, family, group, milieu, and preventive community intervention. ½ unit. Prerequisite: Psychology 444. Registration in Psychology 447 is strongly recommended.

446. **Laboratory in Behavior Modification.** Practice in techniques of behavior modification with a focus on recent innovations. Research implications of the newer methods are examined. Small sections of the course are formed according to the specialized interests of students and staff. ½ unit. Prerequisite: Psychology 445.

447. **Practicum.** Supervised practice in the assessment and modification of problem behavior. ½ unit. A student may reregister for a maximum of one unit. Prerequisite: Credit or registration in Psychology 445 and 446.

451. **Advanced Social Psychology.** Same as Communications 451. A systematic and critical treatment of individual behavior variables in relation to group variables. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 255 or equivalent. Steiner.

456. **Psychology of Social Communication.** Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 451 or equivalent, or consent of instructor. Fishbein.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Six units of graduate credit in psychology including Psychology 451 or equivalent. Steiner.

459. **Leadership and Group Effectiveness.** Theories of leadership, methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Psychology 451 or equivalent. Fiedler.

461. **Development Psychology.** Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. 1 unit. Prerequisite: Twelve hours of psychology or consent of instructor. Hunt.

462. **Human Abilities.** Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Psychology 307 or equivalent. Humphreys.

463. **Research Methods in Clinical Psychology and Personality.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. ½ unit. Prerequisite: Psychology 306 and 403. Eriksen.

464. **Parental Behavior and Personality Development of Children.** A survey of naturalistic and experimental research relating parent behavior to the personality development of children. Coverage is given to problems of measurement and structure of parent and child behavior, problems in research design, and to important issues for a theory of social learning. 1 unit. Prerequisite: Psychology 306 or equivalent; consent of instructor.

467. **Personality Assessment.** Methods and theory in the quantitative assessment of personality; review of research findings and trends. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Psychology 307 or equivalent. W. C. BECKER, WIGGINS.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. GRICE.

483. **Psychology of Speech and Hearing Disorders, I.** Same as Speech 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** Same as Speech 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

485. **The Sampling of Human Populations and Social Organizations.** Same as Sociology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples—stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

490. **Individual Research.** For graduate students who wish to conduct research on special problems not included in graduate theses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

492. **Psychology of Learning and Instruction.** Same as Educational Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON, STOLUROW.

493. **Seminar.** Discussion of current topics in their historical setting, with special emphasis on research problems. ½ or 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. STAFF.

494. **Multivariate Analysis in Psychology and Education.** Same as Educational Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Education Psychology 496; consent of instructor. TUCKER.

495. **Theory of Measurement.** Same as Educational Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307, or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. HASTINGS, TUCKER.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Quantitative Methods, I.** A lecture and laboratory course in the development and application of quantitative methods in psychological research. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. KAPPAUF, TATSUOKA, WHIMBEY.

307. **Quantitative Methods, II.** Continuation of Psychology 306. 1 unit. Prerequisite: Psychology 306. KAPPAUF, TATSUOKA, WHIMBEY.

311. **Physiological Psychology.** A survey of classical and current problems, with emphasis on the nervous and endocrine systems in information processing and in the regulation of behavioral adaptation, with examples from sensation, perception, motivation, emotion, and learning. Laboratory. ½ or 1 unit. Prerequisite: Six hours of psychology; Physiology 103 or 106, or Zoology 104.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. ½ or 1 unit. Prerequisite: Six hours of psychology. O'KELLY.

330. **Experimental Psychology, I.** A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. ½ unit. Prerequisite: Psychology 235. HAKE.

331. **Experimental Psychology, II.** A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. ½ unit. Prerequisite: Psychology 235. GRICE.

332. **Research Methods in Social Psychology.** A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology 235 and 255. FISHBEIN, MCGRATH.

335. **Mathematical Formulations in Psychological Theory.** Mathematical formulations are illustrated by studying quantitative treatments of various psychological processes. Emphasis is on learning theory, psychophysical laws, and other selected topics. Simple mathematical tools will be developed as required. ½ or 1 unit. Prerequisite: Elementary statistics or probability, elementary calculus, and six hours of psychology, or consent of instructor. FRANKMANN.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. ½ or 1 unit. Prerequisite: Six hours of psychology. PETERSON.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. ½ or 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. MCALLISTER.

346. **Behavior Genetics.** Examination of the relations between genetic mechanisms, population structure, and individual differences in behavior; survey of research and possible extensions of research on the genetics of behavior; laboratory work on techniques of behavior study and genetic analysis. ½ or 1 unit. Prerequisite: Psychology 100 or 103; course in statistics. HIRSCH.

348. **The Psychology of Learning.** A survey of the basic facts and theories of the learning process. ½ or 1 unit. Prerequisite: Six hours of psychology. MOWRER.

355. **Industrial Social Psychology.** Same as Labor and Industrial Relations 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid in understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or 357. H. C. Triandis.

356. **Human Factors in Equipment Design.** The contributions of psychological research to the design of equipment for efficient human use and operation. Studies of the characteristics and limitations of the human individual which bear upon the equipment and machines best suited to his use. A survey of research on visual and auditory displays, controls, layout of consoles; complex man-machine systems; vigilance and isolation effects; design for efficient trouble-shooting and maintenance. Emphasis is placed upon the methods used in collecting data on these problems. Applications to engineering, industrial design, management, etc., are discussed. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics.

357. **Psychology of Industrial Conflict.** Same as Labor and Industrial Relations 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. Hulin.

358. **Human Performance in Man-Machine Systems.** Examination of equipment and training variables that influence the human operator and the effectiveness of man-machine systems; methods of task analysis for the systematic determination of behavioral requirements; design and use of simulators and other training devices; measurement of operator proficiency; control and display variables in closed-loop tracking systems; motor and perceptual fatigue; effect of work load; contemporary issues. Field trips. Research project on equipment design. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. Adams.

360. **Modern Viewpoints in Psychology.** A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and psychoanalytic theory—as conceptions of man and as approaches to the study of learning, perception, personality, and social behavior. ½ or 1 unit. Prerequisite: Nine hours of psychology with an average grade of B, or consent of instructor. Dulany.

365. **Experimental Child Psychology.** Stress is placed on laboratory investigations of children's behavior, including perception, learning, and problem-solving. ½ or 1 unit. Prerequisite: Six hours of psychology with an average grade of B; a course in statistics. Weir.

371. **Psychological Factors in Political Behavior.** An application of psychological methods and theories to the study of political behavior. Special attention is given to research methods and to content problems in voting behavior and national security policy. ½ or 1 unit. Prerequisite: Six hours beyond 100-level courses in psychology, political science, or sociology.

373. **Human Development in Cross-Cultural Perspective.** Same as Anthropology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, psychology, or sociology, or consent of instructor. Casagrande, L. M. Triandis.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 374. Methodologies

for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369.

390. **Psychological Tests and Measurements.** The measurement of human behavior in psychological studies; the construction and use of psychological tests; introduction to tests of intelligence, achievement, personality, and interest; practice in test construction, administration and validation. Lectures and laboratory. 1 unit. Prerequisite: Psychology 235.

RADIO AND TELEVISION

The Department of Radio and Television offers work leading to the Master of Science in Radio and Television and the Master of Television. For the program leading to the Doctor of Philosophy in Communications, see page 112.

Admission to the program leading to the Master of Science requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in radio-television or a related field, English, or the social sciences; (2) a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

Admission to the program leading to the Master of Television requires (1) meeting minimum requirements for admission to the Graduate College; (2) a bachelor's degree from an accredited institution, ordinarily with a major in radio, television, theatre arts, journalism, or some other area related to television; (3) the approval of an entrance committee.

Master of Science in Radio and Television. Requirements for this degree include:

(1) A major of four units or three units and one additional unit approved by the adviser. Candidates must complete Radio-Television 462 or Journalism 471. Candidates without acceptable undergraduate majors are required to complete Radio-Television 252 (Television Laboratory), 368, and Advertising 386.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A one unit thesis.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

Master of Television. This degree differs from the Master of Science program in these ways: it does not require a thesis, but instead requires study in special problems of television; it does not require a minor, but permits concentration in the fifth year in the radio and television field.

Requirements for the degree include a total of eight units of credit, with a minimum of six units selected from courses in the television sequence. The following courses must be included among these six units if they or their equivalents have not been completed on the undergraduate level: Radio-Television 462, one unit; Radio-Television 450, two units; Radio-Television 368, one-half unit, and Advertising 386, one-half unit. Candidates without undergraduate training acceptable for the program are required to complete the following undergraduate courses: Radio Television 252 (Television Laboratory) and Radio-Television 261 (Principles of Radio and Television Broadcasting); but under exceptional circumstances, such as professional experience in television broadcasting, this requirement may be waived.

Students are expected to plan their programs around a special interest area which may include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

GRADUATE FACULTY

Professor: H. J. Skornia.

Associate Professors: H. V. Cordier (Head of Department), F. E. Schooley, W. L. Smalley.

Assistant Professor: H. W. Lippold, Jr.

Instructors: S. W. Saltzman, B. L. Sims.

COURSES FOR GRADUATES

450. Special Problems in Television. Project work for advanced students in specific areas of television, including news, advertising, directing, writing, etc. 1 to 2 units. Prerequisite: A television course in the area of specialization; consent of instructor. Staff.

451. Television Program Management and Production. Problems in originating, planning, and producing television programs. 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor. Cordier.

462. Seminar in Radio and Television. Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. Skornia.

463. World Broadcasting. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor. Skornia.

490. Special Topics in Radio and Television. ½ or 1 unit. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in radio-television. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

350. Broadcast Playwriting. Fundamentals of radio and television dramatic writing; adaptations and original projects in both media. ½ unit. Prerequisite: Consent of instructor. Smalley.

354. Television Directing. The theory and techniques of directing the television program. Experience in directing laboratory productions. ½ unit. Prerequisite: Radio-Television 252; consent of instructor. Cordier.

355. Television News. News coverage, script preparation, use of visual materials, and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. ½ unit. Prerequisite: Consent of instructor. Lippold.

356. Cinematography for Television. The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. ½ unit. Prerequisite: Consent of instructor. Sims.

360. Educational Uses of Television and Radio. Same as Communications and Educational Psychology 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. McIntyre, Skornia.

362. Radio and Television Station Management. A study of the organization and administration of the radio and television staff and station; public relations, personnel management, and station operation; analysis of station and agency rela-

tionships and radio and television sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. ½ unit. Prerequisite: Radio-Television 261. SCHOOLEY.

365. **Radio News.** News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. ½ unit. Prerequisite: Journalism 211. CRAMER.

366. **Advanced Radio and Television Practices, I.** Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. **Advanced Radio and Television Practices, II.** Continuation of Radio-Television 366. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. **Radio and Television Regulation.** Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. ½ unit. SCHOOLEY.

RECREATION AND MUNICIPAL PARK ADMINISTRATION

The Department of Recreation and Municipal Park Administration offers a program of graduate study leading to the Master of Science in Recreation. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in recreation, see page 281.) This program primarily prepares leaders, supervisors, administrators, teachers, and research workers in community recreation, but it also offers opportunities for preparation in the related fields of park administration, therapeutic recreation and rehabilitation, outdoor recreation, and college union administration, as well as recreation work with private agencies, business and industry, commercial recreation enterprise, etc.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last sixty semester hours; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Requirements for this degree are eight units including (1) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science, psychology, social work, and sociology; (2) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (3) registration in and satisfactory completion of Recreation 490, without credit; (4) presentation of an acceptable thesis in recreation, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

GRADUATE FACULTY

Professors: C. K. BRIGHTBILL (Head of Department), A. V. SAPORA, E. H. STOREY.

Associate Professor: H. E. WEAVER.

Assistant Professor: M. VIRGINIA FRYE.

Lecturer: R. E. OWENS.

COURSES FOR GRADUATES

401. Foundations of Recreation. Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. 1 unit. Prerequisite: Recreation 176 or equivalent. BRIGHTBILL.

402. Recreation Administration. Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent. BRIGHTBILL.

403. Evaluation of Recreation Resources and Programs. Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; research in the field of recreation. 1 unit. Prerequisite: Recreation 176 or 375, or equivalent; a course in tests and measurements or statistics. SAPORA.

404. Outdoor Education and Recreation. Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. WEAVER.

490. Seminar. Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. No credit. STAFF.

493. Special Projects. Independent research on special projects. Open only to students majoring in recreation. ½ to 2 units. Prerequisite: Recreation 403 or equivalent. STAFF.

499. Thesis Research. Preparation of theses in recreation. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. Introduction to Administration. Organization of public and private agency programs, leadership, facilities and services; introduction to recreation administration. ½ or 1 unit. Prerequisite: Recreation 176. RUHE, SAPORA.

385. Park Management. An intensive study of the principles, practices, and problems involved in managing public park systems. Designed to provide a professional background including the history of parks, organization, planning, examination of facility design and layout, maintenance, finance, and operation of park systems. ½ or 1 unit. Prerequisite: Landscaping Architecture 226, Urban Planning 171, Political Science 305, Recreation 278 and 279, or equivalent. OWENS, RUHE.

390. Principles of Therapeutic Recreation. Concepts, principles, objectives, methods, and settings of recreation for the ill and handicapped. ½ or 1 unit. Prerequisite: Recreation 176 and 208 or 209, or consent of instructor. FRYE.

395. Recreational Use of Public Lands. A study of lands in the public domain, and their historical, current, and potential use for outdoor recreation. It includes; an analysis of land, woods, and water in the public domain; the demand for outdoor recreation; multiple use concept of natural resources; functions and policies of federal and state governments and their agencies; the economics of outdoor recreation; and the future of outdoor recreation in America. ½ or 1 unit. Prerequisite: Recreation 176, Geography 214, and Economics 108, or consent of instructor. STOREY.

RUSSIAN LANGUAGE AND AREA STUDIES

Graduate programs in Russian language and area studies are offered by the Center for Russian Language and Area Studies in cooperation with various departments.

Minor for the Master's Degree. A candidate for the master's degree who elects Russian language and area studies as a minor must earn at least two units of graduate credit in courses chosen from the following: anthropology, economics, geography, history, law, political science, Russian, and sociology. The courses chosen must be in at least two departments.

Minor for the Doctor of Philosophy Degree. A doctoral candidate who elects Russian language and area studies as a minor must demonstrate a reading command of Russian as tested by examination or by completion of Russian 104 or 401 with a grade of A or B, and in addition must earn at least four units of graduate credit in courses chosen from the list given just above. The four units must include courses from at least two departments outside of, and may at the same time include up to one unit from within, the department offering the candidate's major.

Certificate of Graduate Specialization in Russian Language and Area Studies. This certificate is awarded by the Graduate College and the Center for Russian Language and Area Studies. It is for persons with the baccalaureate who are enrolled in advanced studies in any discipline and who wish at the same time to gain a knowledge of the Russian area and language. The requirements are: (1) A good command of written and spoken Russian, as determined by special examinations, or a grade of A or B in Russian 104 or 401. (2) At least six graduate units relating to Russia, distributed among at least three of the departments represented in the program (anthropology, economics, geography, history, law, political science, Russian, and sociology) other than the student's own major department. If the student's major department is one of these eight he may count, as part of his six units, up to one unit from within his major department. (3) A special essay based largely on Russian sources, which must meet, at the minimum, the standard normally required in a master's thesis. The student may submit, in fulfillment of this requirement, a copy of his master's thesis or doctoral dissertation.

The adviser for the graduate minors and the Certificate is Professor Ralph T. Fisher, Jr., Director of the Center for Russian Language and Area Studies, 1207 West Oregon Street, Urbana.

GRADUATE FACULTY

Professors: R. T. Fisher, Jr. (Director of Center for Russian Language and Area Studies), J. D. Fellmann, D. R. Hodgman, E. G. Lewis, L. R. Micklesen, D. B. Shimkin, V. Terras, A. Vucinich.

Associate Professors: K. Klein, T. Pachmuss.

Assistant Professors: S. P. Hill, J. F. Hough, H. H. Kaplan, P. B. Maggs, B. Uroff.

SLAVIC LANGUAGES AND LITERATURES

(Including Russian and Ukrainian)

The Department of Slavic Languages and Literatures offers graduate work leading to the Master of Arts in Russian, Master of Arts in the Teaching of Russian, and Doctor of Philosophy in Russian.

Students with a minimum grade-point average of 4.0 are regularly admitted to graduate courses, subject to fulfillment of other prerequisites. Students with a grade-point average between 3.5 and 3.99 are admitted upon approval of the department.

Students electing Russian as a major subject should have had the equivalent of at least four years of Russian in college, including practical work in the use of the language and an advanced course in literature.

Students choosing Russian as a minor subject should consult the department.

Master of Arts in Russian. In addition to fulfilling the general requirements of the Graduate College, candidates must pass both a written and an oral examination. Students may major in literature or linguistics and may offer a minor. Students majoring in literature must present at least two courses in linguistics; those majoring in

linguistics must present at least two courses in literature, and in addition, some training in another Slavic language.

Master of Arts in the Teaching of Russian. Candidates for this degree are required to take: (1) Russian, five units: up to three units from 300 courses not taken in an undergraduate program, and at least two units from courses open only to graduates; (2) Education, two units: Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 303, 304, 305; (3) electives, one unit. These courses must be selected with the approval of the adviser. Candidates must pass an examination based on their course work and on a reading list.

Doctor of Philosophy in Russian. All candidates for this degree must fulfill the general requirements of the Graduate College and must have a reading knowledge of French and German. A student may major in literature or linguistics, but must offer a minor, preferably in another language or literature, comparative literature, or linguistics. Those students majoring in literature must present at least four courses in linguistics, as well as training in another Slavic language; students majoring in linguistics must present at least four courses in literature, along with some training in two other Slavic languages.

GRADUATE FACULTY

Professors: C. L. Dawson (Chairman of Department), L. R. Micklesen.

Associate Professors: K. Klein, Temira Pachmuss.

Assistant Professor: S. P. Hill.

Russian

COURSES FOR GRADUATES

400. **Beginning Russian for Graduate Students.** Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit.

401. **Readings in Russian for Graduate Students.** Grammar, vocabulary, general and special readings. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit. Prerequisite: Russian 400 or equivalent.

405. **Old Church Slavonic.** Analysis of grammar, reading of texts, discussion of development of the Slavic languages. 1 unit. Prerequisite: Russian 380.

406. **Russian Morphology.** A survey of the various parts of speech of modern standard literary Russian with special emphasis on the nominal and verbal systems. 1 unit.

407. **Russian Syntax.** A survey of historical and contemporary Russian syntax. 1 unit. Prerequisite: Russian 406 or consent of instructor.

410. **Literature of the Eleventh to the Sixteenth Century.** Reading of texts. Historical and literary background of the period. 1 unit. Prerequisite: Russian 417 or consent of instructor.

412. **Literature of the Seventeenth and Eighteenth Centuries.** Reading of texts. Historical and literary background of the period. 1 unit.

413. **Modern Russian Drama.** A study of the Russian theatre from the eighteenth to the twentieth century. Plays by Russian authors are examined against the background of Russian and Western dramatic theories. 1 unit. Prerequisite: Russian 322 and 324.

414. **Pushkin.** The age of Pushkin; Pushkin's works in historical and comparative perspective; textual criticism, linguistic and structural analysis, intellectual interpretation, and aesthetic evaluation. 1 unit. Prerequisite: Russian 321.

415. **Dostoevsky.** Dostoevsky: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Russian 323.

416. **Studies in Russian Criticism.** 1 unit. Prerequisite: Russian 322 and 324.

417. **History of the Russian Language.** 1 unit. Prerequisite: Russian 405.

418. **Oral Poetry and Slavic Poetics.** Linguistic material and poetic form. Oral poetry in its genres, motifs, and themes; their unity and diversity in the cultural history of Slavic peoples; the impact of oral poetry on literary tradition. 1 unit.

419. **Tolstoy.** Tolstoy: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Russian 322.

420. **Chekhov.** Chekhov: historical background; textual criticism; structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Russian 324.

421. **Seminar in the Russian Novel.** Dostoevsky, Tolstoy, nineteenth-century novel, twentieth-century novel. 1 unit. May be repeated for a total of three units. Prerequisite: Russian 322 and 324.

423. **Seminar in Russian Poetry.** Pushkin, narrative verse, lyric verse, symbolism. Course may be repeated for credit not to exceed three units. 1 unit. Prerequisite: Russian 322, 324, or consent of instructor.

460. **Comparative Slavic Phonology.** The phonological structure of Common Slavic at the time of dissolution of the primitive Slavic community; the characteristic tendencies in the evolution of sound and prosodic systems in the East, West, and South Slavic languages groups; the phonemic patterns of single modern Slavic languages outlined as a basis for a typological classification of Slavic languages. 1 unit. Prerequisite: Russian 380.

461. **Comparative Slavic Morphology.** A lecture course designed to trace the development of the principal parts of speech, their various inflectional and derivational morphemes and their attendant grammatical categories from Common Slavic to the various modern Slavic languages, and to make comparisons among the modern synchronic morphological treatments of these languages. 1 unit. Prerequisite: Russian 460.

491. **Individual Topics.** ¼ to 2 units. Prerequisite: Graduate standing with a major or minor in Russian.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Russian Phonetics and Diction.** Theoretical and practical work on pronunciation and intonation in Russian, with special attention to the problems of teachers. ½ unit. Prerequisite: Russian 212 or consent of instructor.

309. **Russian Literature in Translation, I.** Survey of Russian literature from the Kievan period to Turgenev; cultural and historical background of the period. No knowledge of the Russian language is required. ¾ unit.

310. **Russian Literature in Translation, II.** Survey of Russian literature from Dostoevsky to Symbolism; cultural and historical background of the period. No knowledge of the Russian language is required. ¾ unit.

311. **Advanced Russian Conversation.** Practice in free conversation with a native speaker. ¼ unit. Prerequisite: Three years of college Russian, including Russian 211 and 212, or consent of instructor.

312. **Soviet Literature in Translation.** Survey of Russian literature since the 1917 Revolution; cultural and historical background of the period. No knowledge of the Russian language is required. ½ unit.

313. **Advanced Russian Composition.** Practice in advanced composition and study of advanced problems of grammar, syntax, and style. ¼ unit. Prerequisite: Three years of college Russian, including 213 and 214, or consent of instructor.

321. **Readings in Russian Literature: Pushkin, Lermontov, Gogol.** Representative works of the period 1820-1850; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

322. **Readings in Russian Literature: Dostoevsky and Tolstoy.** Representative works in their historical and cultural contexts. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

323. **Readings in Russian Literature: Turgenev, Goncharov, Ostrovsky.** Representative works of the period 1850-1880; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

324. **Readings in Russian Literature: Chekhov, Górky, Blok.** Representative works of the period 1880-1917; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

325. **Readings in Soviet Literature.** Representative works of Russian literature since 1917: Mayakovsky, Leonov, Sholokhov, and others; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 202 or consent of instructor.

326. **Masterpieces of Russian Literature.** Masterpieces of Russian literature: historic background, textual analysis, structure, philosophy and ideology, aesthetic evaluation. This course is designed primarily for students in teacher training programs. ¾ unit. Prerequisite: Russian 201 and 202.

331. **Slavic Civilization and Literatures.** A survey of Slavic institutions and life as reflected in Slavic literatures other than Russian, Polish, Czech, Ukrainian, etc., and their connection with Russian traditions. ¾ unit. Prerequisite: Reading knowledge of Russian or one other Slavic language, or consent of instructor.

332. **Traditions of Russian Literature and Thought.** The rise and development of Russian social and philosophical thought in the nineteenth century and its impact on literature. ¾ unit. Prerequisite: Consent of instructor.

333. **The Russian Short Novel.** Theory and techniques of the *povest'* and related forms in the nineteenth and twentieth centuries. S; ½ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

380. **Introduction to Slavic Linguistics.** Same as Linguistics 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit. MICKLESEN.

382. **Language Laboratory Techniques.** Same as French, German, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. S; ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

Ukrainian

COURSES FOR GRADUATES AND UNDERGRADUATES

396. **The Structure of Ukrainian.** Ukrainian phonology, morphology, and syntax presented with Russian as a background and basis for comparison of these two East Slavic languages. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Russian 104 or equivalent.

398. **Readings in Ukrainian Literature.** Representative works of Ukrainian literature and their historical and cultural background. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Ukrainian 396 or consent of instructor.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including anthropology, economics, geography, history, philosophy, political science, psychology, social work, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work required for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor J. B. Casagrande, 137b Davenport Hall. The general adviser for this degree is Professor George Manner, 321 Lincoln Hall.

Master of Arts in the Teaching of Social Studies. Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. The courses in the social studies should be selected from not more than three of the following fields; history (two units required), economics, geography, philosophy, political science, and sociology. The courses in education must include Educational Psychology 311, 312, Secondary and Continuing Education 456, and History and Philosophy of Education 304 and 305. The courses in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

The adviser for candidates for this degree is Professor Charles E. Nowell, 310 Armory.

SOCIAL WORK

The Jane Addams Graduate School of Social Work offers two years of graduate professional study leading to the Master of Social Work. Although the basic curriculum of the School is the same for all students, there are opportunities for specialization in casework and group work. Students specializing in group work have their classes on the University of Illinois Chicago Circle campus and field placements in group work agencies in the city. Those specializing in casework may have classes on either the Urbana or Chicago campus, with field placements in selected agencies nearby.

The School has established an admissions committee which is responsible for reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. The applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthful relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

The School is compelled to limit enrollment to the number of field work placements available.

The courses listed below describe the program offered on the Urbana campus. Similar courses are offered in Chicago under a quarter term calendar, and the group work sequence is offered only there. For information about the Chicago program, the School's special catalog should be consulted.

Application must be made to the Jane Addams Graduate School of Social Work. The special catalog issued by the School may be obtained by writing to the Director, Jane Addams Graduate School of Social Work, University of Illinois, 1207 West Oregon Street, Urbana 61801.

GRADUATE FACULTY

Professors: M. P. Hale (Director of the School of Social Work), Jennette R. Gruener, Florence L. Poole, W. P. Simon, D E. Tanenbaum.

Associate Professors: Lela B. Costin, Margaret G. Holden, D. E. Lathrope, J. E. McDonald, Aleanor R. Merrifield, Mary E. Sullivan, M. A. Taber, L. Jane Wille.

Assistant Professors: J. J. Alderson, Eloise J. Cornelius, S. Mirelowitz, Martha C. Munk, H. Treger, A. J. Vattano.

COURSES FOR GRADUATES

421. **Social Work Methods, I.** Principles and practice of social work integrating classroom and field instruction. Sections A1 and A2 are required of all students; Sections B1 and B2 of casework majors. 2 to 4 units.

Section A1. Community Organization. Emphasis is on the community organization component of social work practice in various settings. Beginning knowledge and illustrative elements of the practice of community organization at the neighborhood, community, county, metropolitan region, state, national, and international levels. ½ unit.

Section A2. Research. Objectives and methods of social work research. Basic principles of designing studies, evaluation of methods of collecting data, construction of schedules, analysis and presentation of results. Prerequisite: A course in elementary statistical method. In lieu of this, a noncredit course in statistical method may be taken concurrently. No credit.

Section B1. Social Casework. Consideration of the principles of social work in the practice of social casework. Through discussion of case material from various settings and from his own field experiences, the student is helped to understand social casework method and to use this in helping the client. ½ unit.

Section B2. Field Instruction. The student is assigned to a social agency in which, under the supervision of a qualified field instructor, he has responsibility for carrying selected cases. Instruction is based on the student's own practice and is designed to help him develop skill in social work methods. 1 unit.

422. **Social Work Methods, II.** Continuation of Social Work 421. More extensive analysis and application of the principles of casework and group work. Sections A1 and A2 are required of all students; Sections B1 and B2 of casework majors. 2 to 4 units. Prerequisite: Social Work 421.

Section A1. Generic Principles: Casework and Group Work. Study of principles underlying similarities and differences in giving and taking help within casework and group work relationships. For the student who is concentrating on casework practice, the focus is on working with group situations inherent in casework settings. No credit.

Section A2. Research. Continuation of Social Work 421, Section A2. Critical analysis of research studies in human growth and development, social work methods, and social welfare services. ½ unit.

Section B1. Social Casework. Continuation of Social Work 421, Section B1. Designed to help the student increase his knowledge and improve his skill in the practice of social casework. ½ unit.

Section B2. Field Instruction. Continuation of the first semester of field instruction. 1 unit.

423. **Social Work Methods, III.** Emphasis is on the student's understanding and skill in social work with broader consideration of practice in various settings. Section A1 is required of all students; Sections B1 and B2 of casework majors. 2 to 4 units. Prerequisite: Social Work 422.

Section A1. Social Work Practice. Social work method in different settings. Ways of determining the nature and content of social work services in various settings; methods of developing effective working relationships in multi-discipline settings. Consideration of content specific to various kinds of agencies in which social work is practiced. ½ unit.

Section B1. Social Casework. Continuation of Social Work 422, Section B1, with increased emphasis on the generic, diagnostic, and differential treatment aspects of social casework. Application of the case study method to a variety of settings in which social casework is practiced. ½ unit.

Section B2. Field Instruction. Based on the student's own practice in a setting related to his field of specialization. Emphasis is on enhancing the student's skill in practice. 1 unit.

424. **Social Work Methods, IV.** Continuation of Social Work 423. Section A1 is required of all students; Sections B1 and B2 of casework majors. 2 to 4 units. Prerequisite: Social Work 423.

Section A1. Social Work Practice. Social work practice in areas of supervision, consultation, and administration. Emphasis for the casework student is on the understanding of the worker's role in consultation, policy-making, program planning, and interpretation. ½ unit.

Section B1. Social Casework. Continuation of Social Work 423, Section B1. Learning experiences arranged to assist the student to a greater integration of the philosophy, concepts, and principles in social casework. ½ unit.

Section B2. Field Instruction. Continuation of the third semester of field instruction. 1 unit.

451. **Dynamics of Human Development, I.** Designed to provide the student with an understanding of normal physical, emotional, and social growth throughout the life cycle. Relevant material is included from the fields of medicine, psychology, psychiatry, and cultural anthropology. 1 to 2 units.

453. **Dynamics of Human Development, II.** Understanding of deviations from normal physiological functioning as demonstrated in major chronic disease processes. Interrelationship of physical, emotional, and social aspects of causation of disease and implications for the patient, family, and community. Discussion of the role of the social worker in collaboration with other disciplines concerned with provision of medical and rehabilitative services. 1 to 2 units. Prerequisite: Social Work 451.

454. **Dynamics of Human Development, III.** Concepts and theories used in social work to understand the nature and causes of emotional pathology in social functioning. 1 to 2 units. Prerequisite: Social Work 453.

461. **Special Studies in Social Work, I.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. 1 to 2 units.

462. **Special Studies in Social Work, II.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. 1 to 2 units.

481. **Social Welfare Organization, I.** Analysis of social welfare as part of the social structure, followed by a historical study of its development, aimed at accounting for the present position of social work and social welfare in American culture. The emergence of specialized services, the contribution of private philanthropy, the expansion of public responsibility, the interrelations of social welfare with other aspects of the culture and historical developments. 1 to 2 units.

482. **Social Welfare Organization, II.** Principles and content of public and private programs directly affecting family welfare, particularly income maintenance and related services. Consideration of the social insurances, public assistance, employment services, labor standards, protective legislation, and community-sponsored family service programs. Focus is on basic premises, content, objectives, and adequacy of each program as a means of providing protection against economic want, and the maintenance and restoration of the social functioning of individuals and families. 1 to 2 units. Prerequisite: Social Work 481.

483. **Social Welfare Organization, III.** Examination of proposals to strengthen programs and services in each of the national, state, and community social welfare programs in the light of evolving needs and changing resources. Consideration of public health, medical care, health insurance, chronic illness and disability, rehabilitation services, mental health care, services for children, urban renewal, programs for the aging, correctional services, and informal education and leisure-time programs. 1 to 2 units. Prerequisite: Social Work 482.

484. **Social Welfare Organization, IV.** Analysis of organizational patterns and of the administrative process; study of the structures of international, national, state, and local public and private agencies to reveal their functions and interrelationships; review of the administrative process through examination of policy formulation, the executive function, organization, coordination, field services, personnel, budgeting, and public relations. Social action and the legislative process, and current developments and issues in the area of social work are examined. 1 to 2 units. Prerequisite: Social Work 483.

491. **Research Seminar.** Seminar for students preparing research projects, either in groups or individually. Experience in the application of research methods to current social work problems. 0 to 2 units. Prerequisite: Social Work 421 and 422, Section A2.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Introduction to Social Casework.** Behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of these upon the contacts of social caseworkers with individuals and families. Attention is given to case records selected from social casework practice in public assistance and other community agencies. ½ unit. Prerequisite: Consent of instructor.

316. **Social Services for Children.** Unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard-setting in social services for children. ½ or 1 unit. Prerequisite: A major in any of the social sciences, education, recreation, speech correction; consent of instructor.

333. **Introduction to Social Group Work.** Background information regarding the place and development of social group work. Attention is given to the nature of

groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. ½ unit. Prerequisite: Introductory courses in sociology, psychology, and social sciences; consent of instructor.

SOCIOLOGY

The Department of Sociology offers graduate work leading to the Master of Arts and Doctor of Philosophy.

In order to be considered for admission, students intending to major in sociology must offer:

(1) A grade-point average of at least 4.0 (applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis) ;

(2) A minimum of nine semester hours of undergraduate work in sociology;

(3) One or more courses in quantitative research methods in sociology;

(4) Fifteen semester hours in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

The prerequisite for a graduate minor in sociology is six hours of undergraduate work in sociology.

Master of Arts. The requirements for the Master of Arts are: (1) eight units, including Sociology 385, 386, and 400, and no more than one unit of thesis credit; (2) passing the master's comprehensive examination; (3) preparation of an acceptable thesis; (4) passing an oral examination on the thesis.

Doctor of Philosophy. The applicant who has obtained his Master of Arts from the University of Illinois is judged as to his qualifications for further advanced work on the basis of his performance on the master's comprehensive examination. The applicant whose previous graduate work was done elsewhere may be admitted on a provisional basis. Study for the doctorate must include Sociology 385, 386, 387, and 400, or equivalent.

GRADUATE FACULTY

Professors: D. Glaser (Head of Department) , B. Farber, C. L. Folse, J. R. Gusfield, J. E. Hulett, Jr., B. Karsh, D. E. Lindstrom, L. Schneider, A. Vucinich.

Associate Professors: D. Bordua, J. P. Clark, H. M. Johnson, B. Lazerwitz (on leave 1965-1967) , Rita Simon, H. Y. Tien.

Assistant Professors: S. M. Clark, K. W. Dickman, T. J. Duggan, G. J. McCall, R. F. Tomasson.

Instructor: M. Lewis.

COURSES FOR GRADUATES

400. **General Sociology.** Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. 1 unit. Schneider.

407. **Population Studies and Demographic Analysis.** Same as Rural Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and

psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. Folse.

409. **Psychological Scaling.** Same as Psychology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Psychology 307. Tucker.

411. **Sociology of Science.** Social factors in the origin of broad theoretical orientations in science, such as the mechanistic doctrine, vitalism, historicism, atomism, holism, relativism, and indeterminism; social effects of these orientations; the social origin of scientists; ethos of science; the relationship of science to culture change; the variety and nature of scientific institutions. 1 unit. Prerequisite: Sociology 311 or consent of instructor. Vucinich.

412. **Seminar on Social and Cultural Relations of Personality.** Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. 1 unit. Hulett.

414. **Seminar on Social Interaction.** Same as Communications 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

417. **Seminar in the Sociology of Law.** Review and analysis of selected areas of theory and research in the sociology of law. The focus varies from year to year. Topics covered in different years include such areas as civil litigation and the civil courts, police operations and the sociology of law and order, sociological theories of justice and the operations of legal agencies. Students should consult the instructor about the area to be covered in a particular semester. 1 unit. Prerequisite: Sociology 317. Bordua.

418. **Seminar in Industrial and Economic Sociology.** Same as Labor and Industrial Relations 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Sociology or Labor and Industrial Relations 318, or consent of instructor. Gusfield, Karsh, Phillips.

421. **Seminar on Research in Marriage and Family Life.** Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. 1 unit. Prerequisite: Consent of instructor. Farber.

422. **Theory of Social Groups.** A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. 1 unit.

424. **Seminar in Penology.** Sociological analysis of law enforcement, adjudication, and the rehabilitation of criminals, with emphasis on direct contact with agencies having these functions, and the design of research projects relevant to their problems. 1 unit. Prerequisite: Sociology 331 or equivalent. Glaser.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology. Johnson.

431. **Seminar in Criminology.** Analysis of selected research problems on the development of criminological thought and the investigation of the causes of crime. 1 unit. Prerequisite: Sociology 331 or equivalent. BORDUA, CLARK, GLASER.

432. **Critique of Research in Juvenile Delinquency.** Analysis of major investigations into the causes, treatment, and prevention of delinquency and criminality in youth. 1 unit. Prerequisite: Sociology 331 or consent of instructor; Sociology 431 is recommended. BORDUA, CLARK.

435. **Field Instruction and Research in Penal Sociology.** Problems of designing and conducting criminological research in penal institutions; supervised training and practice in the functions of sociologists in prisons. Conducted only in the summer with the first and eighth weeks spent on campus; six weeks are spent in the offices of sociologists in prisons. Application for admission to this course must be made in April prior to the summer session in which enrollment is desired. S; 1 unit. Prerequisite: Sociology 324 and 331, or equivalent; consent of instructor; passing routine employment clearance procedures (including fingerprinting) required by the prison. GLASER.

440. **Political Sociology.** An analysis of the impact of social cleavages and cohesion on the operation of political institutions and movements; the place of conflict and power in sociological theory; composition and behavior of power elites; participation in political associations; national and local power structure; social functions of electoral behavior; modern national and mass political movements. 1 unit. Prerequisite: Sociology 400 or consent of instructor. GUSFIELD.

444. **Seminar in Public Opinion.** Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

450. **Problems of Soviet Society in Transition.** This seminar examines certain major problems inherent in directed social change from an agricultural to an industrial system under a totalitarian regime of the Soviet type. Attention is focused on such areas as the different phases of the revolutionary process, inconsistencies between ideological premises and the demands of industrialism, the unanticipated consequences of social change, the simultaneous impact upon the social system of industrialism and totalitarianism, and implications of the Soviet experience for other countries. 1 unit. Prerequisite: Consent of instructor. VUCINICH.

476. **Urban Communities and Urbanization.** Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. 1 unit.

477. **Rural Community Organization and Development.** Same as Rural Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of rural community organization; the process of community development as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

480. **Sociological Theory and Method.** This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. 1 unit.

482. **Recent Developments in Sociology.** Intensive study of selected topics based on contemporary works of major importance in the development of sociological theory. 1 unit. Students may reregister for a total of two units credit.

485. **The Sampling of Human Populations and Social Organizations.** Same as Psychology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples, stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample de-

signs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

486. **Seminar on Experimental Sociology.** The logic, design, and analysis of laboratory and field experiments, with special emphasis on the controlled investigation of social processes. 1 unit. Prerequisite: Sociology 385 or equivalent, or consent of instructor.

487. **Special Problems in Rural Sociology.** Same as Rural Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

490. **Individual Topics in Sociology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. ½ to 2 units. STAFF.

494. **Multivariate Analysis in Psychology and Education.** Same as Educational Psychology and Psychology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER.

495. **Computer Applications in Social Statistical Research.** Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. DICKMAN.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Social Systems and Institutions.** An advanced discussion of general principles and concepts in sociology; among the topics discussed are culture, social structure, socialization, primary groups, social stratification; their application to problems in political sociology, industrialization, race relations, religion, and delinquency; the bearing of these upon larger problems of social order and social change. Designed for advanced undergraduate majors in sociology and other social sciences and for graduate students in sociology without adequate preparation for graduate work. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor.

311. **Sociology of Intellectual Life.** A comparative sociological analysis of the development of the intelligentsia in Europe and elsewhere. Central concerns include the institutional supports for intellectual work under various social and cultural conditions, the social origin and status of different types of intellectuals, the formation of distinct scientific traditions, and the relationships of these traditions to ideology, literature, and philosophy. This involves a critical scrutiny of the theoretical literature and methodology of the sociology of knowledge. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. VUCINICH.

315. **Sociology of Education.** Same as History and Philosophy of Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

316. **Sociology of Adolescence.** Adolescence in modern societies; social class, ethnic and minority group membership, and other variables as in social development, search for identity, inter-generational conflict, academic and social failure, and juvenile delinquency; the socializing institutions of family, education, peer culture, politics, religion, welfare and social control, the work world and recreation and leisure. Emphasis on research. ½ or 1 unit. Prerequisite: Sociology 100, or Sociology 104 and 105.

317. **Sociology of Law.** A general treatment of the social origins and consequences of law and legal process. Special emphasis is placed on problems of legal change, on the structure and functioning of legal sanctions. Some attention is paid to law and law-like phenomena in other societies, including primitive societies, but the main focus is on American society. ½ or 1 unit. Prerequisite: Sociology 100. BORDUA.

318. **Industry and Society.** Same as Labor and Industrial Relations 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH, PHILLIPS.

320. **Social Roles.** Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. HULETT.

321. **Family, Kinship, and Crisis.** An analysis of family and kinship, with major concentration on the American family. Implications of the American kinship system for trends in courtship and mate selection, interaction among kin, and other areas of family life are investigated. Family crisis is used as a focus for analysis of family organization. ½ or 1 unit. Prerequisite: Sociology 185. FARBER.

322. **Sociology of Bureaucracy and Administrative Organization.** An analysis of major types of formal organizations from the viewpoint of generalized theories of organization and of substantive theories of bureaucratization and rationalization. Among the formal organizations studied are business enterprises and unions, educational and medical institutions, and non-voluntary organizations. The interrelations between bureaucracy, ideology, and social structure are particularly emphasized. ½ or 1 unit. Prerequisite: Nine hours of sociology including Sociology 300, or consent of instructor.

323. **The Small Social Group.** Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

324. **Penology.** Probation; parole; methods of institutional treatment. ½ or 1 unit. Prerequisite: Sociology 331. GLASER.

326. **Social Mobility and Class Structure.** An advanced course in social stratification, concerned with patterns, causes, and consequences of social mobility and immobility. Includes the analysis of rising and falling classes in industrial and developing countries and the circulation of political, social, and economic elites, as well as institutional sources of individual mobility. ½ or 1 unit. Prerequisite: Sociology 223 or consent of instructor.

329. **Comparative Family Institutions.** Cross-cultural analysis of family institutions, with special reference to vital and demographic backgrounds and with stress on

property, authority, and handling of deviance, and relationship to religion, economy, and polity. ½ or 1 unit. Prerequisite: Sociology 185. Farber, Lewis.

331. **Criminology.** Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal and cultural conditions. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. Clark.

333. **Sociology of Mental Health.** Mental health issues from social organizational, demographic, and social psychological perspectives; definitions of mental illness and treatment practices relating to changing social psychological and political ideologies. The patient and the mental hospital, and the potential role of the behavioral scientist as an agent of research, treatment, and change, with special reference to current mental health action programs, are investigated. 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, and one course in abnormal psychology and one in social psychology, or consent of instructor.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105. Gusfield.

343. **Social Change in Developing Areas.** Description and analysis of recent social and cultural changes occurring in new nations and developing economies. Special attention is given to problems of traditional social structure undergoing modernization. Social factors in economic growth, caste and class, nation-building, urbanization and population composition, education, family and religion. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or equivalent.

344. **Public Opinion.** Same as Communications 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152. Simon.

350. **Soviet Social Institutions.** This course analyzes the major social institutions of Soviet society. Special attention is paid to the structural consequences of Communist ideology, totalitarianism and industrialism, and to comparison with and implications for American society. The major areas covered are: population data and their sociological implications; history, values, and ideology; political institutions; economic institutions; social stratification and mobility; the nationalities; the family and education, communications and public opinion; socialized medicine. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. The prerequisite does not apply to majors and minors in Russian Language and Area Studies. Vucinich.

360. **Sociology of the Professions.** This course examines the nature, position, functions, and growing importance of the major professions in the contemporary industrial (or industrializing) society. Particularly close attention is paid to the relationship between the social system and the various professional "communities," recruitment, professional socialization, and bureaucratic vs. independent practice. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. Tien, Staff.

371. **Comparative Social Institutions.** This course examines, in a comparative perspective, some of the major institutional complexes of social systems, such as family and kinship structures, occupations, political institutions, and social stratification and mobility. Illustrative materials are drawn from a variety of societies, including primitive nonliterate societies and advanced industrial societies such as the United States, Germany, and the Soviet Union. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor.

372. **Social Aspects of Mass Communications.** Same as Communications and Journalism 372. Media structures related to cultural content and functions; problems of life and society as treated in mass-produced communications. ½ unit.

373. **Latin-American Social Organization and Institutions.** Analysis of contemporary institutional and social class structures in Latin-American communities and societies, and their relationship to certain religious and family patterns; the influence of past and present trends in urbanization, ecological organization, and population growth upon Latin-American social systems and institutional organization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152, or consent of instructor. SOLAUN.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Sociology, Anthropology, Geography, Health Education, Physiology, or Zoology 369. TIEN, STAFF.

385. **Social Statistics, I.** Deals intensively with descriptive statistics, probability, statistical inference, and significance testing by means of both parametric and nonparametric tests, and the various measures of association. 1 unit. Prerequisite: Sociology 185 or Mathematics 122 or 123, or consent of instructor.

386. **Methods of Field Research.** Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. ½ or 1 unit. Prerequisite: Sociology 184 and 185, or consent of instructor. MCCALL.

387. **Social Statistics, II.** Treats analysis of variance, analysis of covariance, multiple and partial correlations, and complicated sampling procedures. A semester problem is developed which emphasizes integration and application of various statistical techniques to sociological problems. ¾ or 1 unit. Prerequisite: Sociology 385.

SPANISH, ITALIAN, AND PORTUGUESE

The Department of Spanish, Italian, and Portuguese offers work leading to the Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are Spanish linguistics, Spanish literature, Latin-American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, or consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for any advanced degree in Spanish must possess or acquire a practical command of the language. For the Doctor of Philosophy, some

knowledge of Latin and Italian or Portuguese is required. The Latin requirement may be met by taking a minimum of one semester of Latin while in residence for the degree. Parallel training in one or more other languages or literatures, such as English, French, German, Greek, Italian, Latin, and Portuguese, is desirable.

Master of Arts.

(1) *Spanish or Latin-American Literature.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 311, 314, 331, or 332, 351, 352; (b) Spanish 405 and Spanish 415 or 417; two of Spanish 421, 422, 423, 424; one of Spanish 431, 432, 433, 434. The course program may be supplemented by courses from the doctoral list, or by courses totaling one unit in a minor and one unit in each of two minors.

(2) *Spanish Linguistics.* Minimum requirements are: (a) linguistics courses: Spanish 351, 352, 451, and 453; (b) literature, three and one-half units from Spanish 305, 306, 307, 308, 311, and 314, plus electives from the 400-level group; and (c) general linguistics: one and one-half units chosen from three courses among the 300-level offerings in linguistics.

Master of Arts in the Teaching of Spanish.

(1) Up to three units from any of the following not included in an undergraduate program: Spanish 305 and 306, or Spanish 307 and 308 (or both sequences), Spanish 311, 314, 331, 332, 351, 352, Linguistics 300; at least three units selected from: Spanish 415 or 417; Spanish 421, 422, 423, or 424; Spanish 431, 432, 433, or 434.

(2) Education, two units; Educational Psychology 311 and 312; History and Philosophy of Education 304 and 305.

The adviser for candidates for this degree is Professor Joseph S. Flores, 219 Lincoln Hall.

Doctor of Philosophy.

(1) *With Specialization in the Renaissance and Golden Age.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; Spanish 415 or 417; one of Spanish 421, 422, 423, 424; Spanish 425 or 426; Spanish 453; two seminars.

(2) *With Specialization in the Nineteenth and Twentieth Centuries.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; two of Spanish 421, 422, 423, 424; Spanish 425 or 426; Spanish 453; two seminars.

(3) *With Specialization in Latin-American Literature.* The minimum requirements, in addition to those for the master's degree, are: one of Spanish 421, 425, 426; three of Spanish 431, 432, 433, 434, 437, and 438; Spanish 453; two seminars; Portuguese 301 and 302, or 491.

(4) *With Specialization in Spanish Linguistics.* The minimum requirements, in addition to those for the master's degree, are: (a) linguistics: Spanish 452 and 454; (b) literature: Spanish 411; one seminar; (c) general linguistics: required as the minor.

Students working toward the Doctor of Philosophy are admitted with provisional departmental status until their performance in graduate work is judged acceptable for full departmental status by the department's graduate committee.

The department should be consulted on the selection of minors. Minors available within the department are Spanish linguistics, Italian, Portuguese, Spanish and Latin-American literature. Other minors are other languages and literatures, history, philosophy, anthropology, linguistics, Latin-American studies, and other closely allied subjects.

Candidates for an advanced degree in Italian or Portuguese should consult the department. Provisions are made to fit individual cases. In special cases, Spanish literature and linguistics may be used reversibly as major and one minor.

GRADUATE FACULTY

Professors: W. H. Shoemaker (Head of Department), J. H. D. Allen, J. O. Crosby, J. S. Flores, H. R. Kahane, L. Leal, M. A. Morínigo, Angelina R. Pietrangeli.

Associate Professor: M. H. Forster.

Assistant Professors: S. W. Baldwin, Jr., W. C. Blaylock, B. Brancaforte, W. L. Meinhardt.

Spanish

COURSES FOR GRADUATES

405. **Spanish Bibliography.** An introduction to bibliographical method and to the principal bibliographical resources for the study of Spanish and Latin-American literature. ½ unit. Blaylock.

411. **Spanish Literature in the Middle Ages.** 1 unit. Allen.

415. **Spanish Literature in the Sixteenth Century.** 1 unit. Crosby.

417. **Seventeenth-Century Literature.** 1 unit. Crosby, Flores, Morínigo.

418. **Seminar in Seventeenth-Century Literature.** 1 unit. Prerequisite: Spanish 311 or 415 or 417. Crosby, Morínigo.

421. **Modern Spanish Novel and Essay.** 1 unit. Shoemaker.

422. **Contemporary Spanish Novel and Essay.** 1 unit. Shoemaker.

423. **Modern Spanish Drama.** 1 unit. Shoemaker.

424. **Contemporary Spanish Drama.** 1 unit. Shoemaker.

425. **Renaissance and Baroque Poetry in Spain.** 1 unit. Crosby.,

426. **Spanish Poetry of the Nineteenth and Twentieth Centuries.** 1 unit. Pietrangeli.

431. **Spanish-American Poetry: Middle America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

432. **Spanish-American Poetry: South America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

433. **Spanish-American Novel: Middle America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal.

434. **Spanish-American Novel: South America.** 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal.

435. **Seminar in Spanish-American Poetry.** 1 unit. Prerequisite: Spanish 431 or 432. Forster.

436. **Seminar in Spanish-American Novel.** 1 unit. Prerequisite: Spanish 433 or 434. Leal.

437. **Spanish-American Drama.** 1 unit. Prerequisite: Spanish 307 or 308. Forster.

438. **Spanish-American Essay.** 1 unit. Prerequisite: Spanish 307 or 308. Leal.

443. **Seminar in Galdós.** Research work in novelistic criticism. Prerequisite: Spanish 305 or 306 and 311 or 314; or Spanish 421 and 422. 1 unit. Shoemaker.

444. **Seminar in Spanish Realism and Naturalism.** Research work in nineteenth-century literary theory and practice in novel and drama. 1 unit. Prerequisite: Spanish 421 and 422. Shoemaker.

445. **Seminar in Twentieth-Century Spanish Literature.** 1 unit. Prerequisite: Spanish 421 or 422 or 423 or 424, or equivalent. Shoemaker.

451. **Survey of Current Research in Spanish Linguistics.** Present-day methods of comparative, historical, and structural linguistics as applied to Spanish. 1 unit. Kahane.

452. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. 1 unit. Kahane, Morínigo.

453. **History of the Spanish Language.** 1 unit. Kahane, Morínigo.

454. **Old Spanish.** 1 unit. Kahane, Morínigo.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

471. **Teaching College Spanish.** A presentation of the problems of the teaching of Spanish and training in their solution, together with a study of procedures, methods, and laboratory techniques. No credit. FLORES.

491. **Special Topics in Spanish.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. ALLEN, CROSBY, KAHANE, LEAL, MORÍNIGO, SHOEMAKER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Romanticism and Realism in Nineteenth-Century Spanish Literature.** A study of representative authors and genres of the nineteenth century, with particular emphasis on the romantic drama and the realistic novel. ½ unit. Prerequisite: Spanish 222 or equivalent.

306. **The Generation of 1898.** A study of representative works of Baroja, Azorín, Unamuno, Maeztu, Valle Inclán, Benavente, A. Machado, and others. ½ unit. Prerequisite: Spanish 222 or equivalent.

307. **Spanish-American Literature to 1888.** A study of the development of Spanish-American literature from the sixteenth century through the end of the Romantic period. ½ unit. Prerequisite: Spanish 222 or equivalent. LEAL.

308. ***Modernismo* and Contemporary Spanish-American Poetry.** A study of Spanish-American poetry from 1888 to the present; some attention is given to *modernista* prose. ½ unit. Prerequisite: Spanish 222 or equivalent. FORSTER.

311. ***Don Quixote* and the Prose of the Golden Age.** Introduction to *Don Quixote,* to its relationship to other selected masterpieces of the Golden Age, and to the main currents and forms of Golden Age prose. ½ unit. Prerequisite: Spanish 305 or 306 or 307 or 308, or equivalent. CROSBY.

314. **Spanish Drama and Poetry of the Golden Age.** ½ unit. Prerequisite: Spanish 305 or 306 or 307 or 308, or equivalent. FLORES, MORÍNIGO.

331. **La Cultura Hispánica España.** Either Spanish 331 or 332 is required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. MORÍNIGO.

332. **La Cultura Hispánica: Hispanoamérica.** Either Spanish 331 or 332 is required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. LEAL, MORÍNIGO.

351. **Phonetics.** ½ unit. Prerequisite: Spanish 222 or equivalent. FLORES.

352. **Syntax.** ½ unit. Prerequisite: Spanish 222 or equivalent. KAHANE.

371. **Spanish for Teachers.** A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 222 or equivalent. FLORES.

382. **Language Laboratory Techniques.** Same as French, German, and Russian 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

Italian

COURSES FOR GRADUATES

411. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** 1 unit. PIETRANGELI.

412. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** 1 unit. PIETRANGELI.

415. **Italian Literature of the Renaissance.** 1 unit. PIETRANGELI.

416. **Italian Literature of the Renaissance.** 1 unit. PIETRANGELI.

451. **History of the Italian Language.** 1 unit. KAHANE.

452. **Seminar in Italian Linguistics.** 1 unit. KAHANE.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

491. **Special Topics in Italian.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for 300-level courses is Italian 101 and 102. Italian 103 and 104 are desirable.

311. **Dante: *La Divina Commedia.*** ½ unit. PIETRANGELI.

312. **Dante: *La Divina Commedia.*** Continuation of Italian 311. ½ unit. PIETRANGELI.

321. **Modern Italian Literature.** ½ unit. PIETRANGELI.

322. **Modern Italian Literature.** ½ unit. PIETRANGELI.

Portuguese

COURSES FOR GRADUATES

405. **Structure of Brazilian Portuguese: Phonology.** Phonetics and phonemics of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 104 or consent of instructor. ALLEN.

406. **Structure of Brazilian Portuguese: Morphology and Syntax.** Morphemics and syntax of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 405 or consent of instructor. ALLEN.

407. **Studies in Brazilian Literature.** Advanced study of literary movements, major writers, and intellectual and cultural ideas in Brazilian literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 301 or consent of instructor.

408. **Studies in Portuguese Literature.** Advanced study of literary movements, major writers, and intellectual and cultural ideas in Portuguese literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 302 or consent of instructor.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

491. **Special Topics in Portuguese.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. ALLEN, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Brazilian Literature.** Survey of the contemporary Brazilian novel. ½ unit. Prerequisite: Portuguese 103 or equivalent.

302. **Introduction to Portuguese Literature.** Survey of the Golden Age of Portuguese. ½ unit. Prerequisite: Portuguese 103 or equivalent.

303. **Luso-Brazilian Civilization and Culture.** Lectures in English, and readings in English or Portuguese, in Brazilian geography, history, politics, sociology, economics, art, and literature from the Discovery to Independence, designed to afford a broad understanding of the origins of Luso-Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Spanish 104 or Portuguese 102 or equivalent, or consent of instructor.

304. **Contemporary Brazilian Civilization and Culture Since 1822.** Lectures in English, and readings in English or Portuguese, in Brazilian geography, history, politics, sociology, economics, art, and literature since Independence, designed to af-

ford a broad understanding of contemporary civilization and culture. ½ or 1 unit. Prerequisite: Spanish 104 or Portuguese 102 or equivalent, or consent of instructor.

SPEECH AND THEATRE

The Department of Speech and Theatre offers courses leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

The admission requirement, in terms of grade-point average, is at least 3.5.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theatre, oral interpretation, speech and hearing science. They may also select a special curriculum in the teaching of speech.

For the Master of Science, students may take a special curriculum in speech correction.

For the Doctor of Philosophy, students may exercise one of four options: rhetoric and public address; the theatre; speech and hearing science; experimental phonetics.

In addition to meeting general regulations of the Graduate College, the Department of Speech and Theatre specifies the requirements listed below.

Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech, including these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theatre, and an advanced course in public speaking or discussion. A thesis may be required.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated.

Master of Arts in the Teaching of Speech. Candidates for the Master of Arts who are interested in public school teaching should meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each; Speech 322 and 423, one unit each; and education, two units, including the following: History and Philosophy of Education 304 and 305, one unit, and Educational Psychology 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of theatre: speech, four units, including Speech 352, 451, 452, and one of the following: Speech 361, 362, or 366; education, two units, including the following: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; electives, two units.

Master of Science in Speech Correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all the requirements may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 475, 476, 481, 483, 484, 486, 488, 489, 491, 495; one unit from History and Philosophy of Education 304 and 305, and one unit from Educational Psychology 311 and 312; two units of electives. The electives may be in speech, in psychology, or, in exceptional cases, in other fields.

Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree in speech or theatre from an accredited institution.

GRADUATE FACULTY

Professors: K. R. Wallace (Head of Department), H. E. Gulley, B. W. Hewitt, H. L. Mueller, R. Murphy, Marie H. Nichols, J. J. O'Neill, J. W. Scott, C. H. Shattuck.

Associate Professors: Mary H. Arbenz, J. J. Bateman, Clara M. Behringer, K. W. Broadrick, K. Burns, A. J. Derbyshire, O. A. Dieter, Genevieve Richardson, T. M. Scheidel, T. O. Sloan, W. L. Smalley.

Assistant Professors: G. L. Cronkhite, Joanna L. Hawkins, T. Herstand, R. L. Ince, F. L. Nasca, Elaine P. Paden, Lois J. Sanders, R. K. Simpson, E. W. Stark, J. W. Wenzel, B. R. Works, W. R. Zemlin.

COURSES FOR GRADUATES

400. **Seminar in Dramatic Form and Structure.** Studies in the relationship of dramatic form and structure to the contemporary production of historical and modern plays. 1 unit. Prerequisite: Speech 361 and 362, or equivalent; consent of instructor. Smalley.

403. **Seminar for Teachers of Speech.** Investigation of current principles, materials, and developments in the field of speech and of their relationship to the teacher. 1 unit. Burns.

411. **The Greek Tradition in Rhetoric and Oratory.** The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. 1 unit. Bateman.

412. **The Roman Tradition in Rhetoric and Oratory.** Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. 1 unit. Dieter.

420. **Quantitative Methods in Rhetorical Analysis.** An introduction to the principles, procedures, and tools of research used in the quantitative analysis of the oral communication situation, including the experimental designs and statistical methods applicable to rhetorical analysis, and the identification, control, and measurement of rhetorical variables. Students participate in planning, executing, and reporting a limited experimental project investigating some oral communication variable. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Introductory course in statistics; consent of instructor. Scheidel.

423. **The Rhetoric of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. 1 unit. Wallace.

430. **Contemporary Theories of Oral Communication.** Systematic study of speechmaking and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. Scheidel.

436. **Seminar in Public Discussion.** Investigation of special problems in public discussion. 1 unit. Offered in 1967-1968 and in alternate years. Murphy.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. 1 unit. Wallace.

441. **Historical Background of Oral Interpretation.** Historical survey of British and American theories of interpretation. 1 unit. Murphy.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. 1 unit. Prerequisite: Speech 441; consent of instructor. Sloan.

451. **Problems in Play Directing in the Educational Theatre.** Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. Behringer.

452. **Problems in Play Production in the Educational Theatre.** Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. Behringer.

461. **Advanced Theatre Techniques.** Individual development of advanced techniques of acting and staging through supervised participation in public productions. S; ½ or 1 unit. Prerequisite: At least one semester of graduate study in the area of theatre; consent of head of the department and of instructor. HERSTAND.

463. **Seminar in the History of Acting.** Studies in the history and theory of the art of acting. 1 unit. Students may accumulate maximum credit of two units. Offered in 1967-1968 and in alternate years. ARBENZ.

465. **Seminar in Theatre Art.** Studies in the aesthetics of the theatre. 1 unit. HEWITT.

466. **The American Theatre Since 1900.** Major developments in acting, production, playwriting, organization, and operation. 1 unit. HEWITT.

468. **Seminar in Theatre History.** Studies in the history of the theatre. 1 unit. HEWITT.

469. **The Stage History of Classic English Plays.** Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor. SHATTUCK.

472. **Psychoacoustics of Speech.** Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

473. **Seminar in Phonetics.** Same as Linguistics 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor.

475. **Experimental Phonetics, I.** Same as Linguistics 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. **Experimental Phonetics, II.** Same as Linguistics 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. **Measurement of Speech, I.** Same as Linguistics 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. ZEMLIN.

478. **Measurement of Speech, II.** Same as Linguistics 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. ZEMLIN.

481. **Seminar in Neuropathologies of Speech and Language.** Advanced study of speech, vocal, and linguistic problems associated with cerebral palsy, aphasia, and mental retardation. 1 unit. Prerequisite: Consent of instructor.

482. **Seminar in Stuttering.** Principles, theories, and methods of clinical management of stuttering behavior in children and adults. 1 unit. Prerequisite: Speech 388.

483. **Psychology of Speech and Hearing Disorders, I.** Same as Psychology 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** Same as Psychology 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Re-

view of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'Neill.

486. **Advanced Clinical Techniques in Speech and Hearing.** Practice of advanced clinical therapy for speech and hearing disorders; semi-independent management of complex, difficult cases; participation in examination and analysis. ½ to 4 units. Prerequisite: Consent of instructor. O'Neill, Staff.

488. **Diagnostic Procedures in Pathologies of Speech and Language.** Study of diagnostic procedures used in the analysis of neuropathologies of speech and language and orofacial and laryngeal pathologies of speech. 1 unit. Prerequisite: Consent of instructor.

489. **Seminar in Orofacial anl Laryngeal Pathologies of Speech.** Advanced study of speech and vocal problems associated with cleft palate, laryngeal dysfunctions and facial-maxillary disturbances. 1 unit. Prerequisite: Consent of instructor.

490. **Medical Aspects of Speech Disorders and Audiology.** Study of acute and chronic hearing and speech disorders traceable to disease of the ear and vocal mechanisms in relation to the techniques and philosophies utilized in a medically oriented environment. 1 unit. Prerequisite: Speech 385, 388, and 486. O'Neill.

491. **Seminar in Hearing Disorders.** Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. 1 unit. Offered in 1966-1967 and in alternate years. Prerequisite: Speech 391. O'Neill.

492. **Advanced Audiology.** Advanced study of rationale and development of principles associated with special techniques, procedures, and methods used in audiology. 1 unit. Prerequisite: Speech 395 and 397. Stark.

495. **Special Problems.** Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. 1 to 2 units. Prerequisite: Consent of head of department. Staff.

499. **Thesis Research.** 0 to 4 units. Bateman, Behringer, Dieter, Gulley, Hewitt, Murphy, Nichols, O'Neill, Scheidel, Scott, Shattuck, Sloan, Smalley, Wallace, Wenzel.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **General Phonetics.** Same as Linguistics 301. Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit. Paden.

307. **The Art of the Screen: Narration.** Same as Communications 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. Mueller.

308. **The Art of the Screen: Exposition and Persuasion.** Same as Communications 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. Mueller.

311. **British Public Address.** Study of representative British speakers from the sixteenth century to the present. Lectures, reports, and papers. ½ or 1 unit. Murphy.

312. **American Public Address.** Study of representative American speeches from the sixteenth century to the present. ½ or 1 unit. Nichols.

322. **Modern Rhetorical Theory.** Significant movements in the development of rhetorical theory in England, France, and America from 1700 to the present. ½ or 1 unit. Broadrick, Nichols.

342. **Oral Interpretation of Poetry.** Analysis and oral presentation of literature representative of various poetic forms. ½ or 1 unit. Prerequisite: Speech 141. Burns, Sloan.

345. **Contemporary Approaches to Oral Interpretation.** Modern concepts underlying the relationship of interpretation to the reader's experience of literature; discussions, reports, oral interpretations of prose forms (including Chamber Theatre and Readers Theatre). ½ or 1 unit. Prerequisite: Speech 141 or consent of instructor. Sloan.

351. **Styles of Acting for Period Plays.** Study and practice of traditional styles of acting in dramas by important playwrights representing major theatrical eras such as Sophocles, Aristophanes, Shakespeare, Racine, Moliere, Congreve, Wilde. Lectures, demonstrations, exercises, performance. ½ unit. Prerequisite: Speech 261 or consent of instructor. Arbenz.

352. **Introduction to Modern Theatre Art.** Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. Hewitt.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. Tymchyshyn.

354. **Theatre for the Child Audience.** A study of the history, objectives, and techniques of play production for the child audience, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. Tymchyshyn.

355. **Advanced Play Directing.** A study of advanced directing techniques; styles of drama; specialized procedures. ½ or 1 unit. Prerequisite: Speech 255 or equivalent. Behringer.

361. **History of the European Theatre to the Renaissance.** The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. Scott.

362. **History of the European Theatre from the Renaissance to 1900.** The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. Scott.

363. **Advanced Playwriting.** Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing the full-length play. ½ or 1 unit. Students may accumulate two units of credit. Prerequisite: Speech 236; consent of instructor. Smalley.

366. **Development of the American Theatre.** The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. Hewitt.

368. **History of Theatre Costume.** A survey of the history of costumes worn on the stage from the classical Greek period to the present. ½ or 1 unit. Prerequisite: Speech 361 and 362, or consent of instructor. Richardson.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. ½ or 1 unit. Prerequisite: Speech 157 and two of the following: Speech 255, 352, 361, 362; or consent of instructor. Works.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. ½ or 1 unit.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. ½ or 1 unit.

375. **Speech Science.** Same as Linguistics 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Speech 301 or consent of instructor. Zemlin.

376. **Speech Science.** Same as Linguistics 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

383. **Development of Spoken Language.** A study of the development of verbal communication from the prelinguistic period to adulthood in the instance of the normal, physically handicapped, and mentally retarded. ½ or 1 unit. Prerequisite: Consent of instructor. O'NEILL.

385. **Speech Correction.** Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation and practice in clinical techniques are provided in the laboratory. ½ unit. Prerequisite: Ten hours of speech or consent of instructor. SIMPSON.

386. **Basic Diagnostic and Therapeutic Principles of Speech Correction.** Instruction and practice in the administration and interpretation of diagnostic tests; discussion and demonstration of clinical approaches used with speech disorders. ½ unit. Prerequisite: Speech 385; credit or registration in Speech 388. PETERSON.

387. **Practicum in Speech Diagnosis and Therapy.** Observation, practice, and research in diagnosis and therapy of speech disorders. ½ unit. Prerequisite: Speech 386; a grade-point average of at least 3.5; consent of instructor. PETERSON, STAFF.

388. **Speech Correction.** Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and glandular disorders. ½ or 1 unit. Prerequisite: Speech 385. SIMPSON.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. ½ or 1 unit. Prerequisite: Speech 301 and 375, or consent of instructor. STARK.

393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling; clinical and classroom practice with children and adults. ½ or 1 unit. Prerequisite: Speech 391; a grade-point average of at least 3.5; consent of instructor. Required in the curriculum of teacher training in speech correction. NASCA.

395. **Audiometry and the Use of Hearing Aids.** Selective and diagnostic tests of hearing, the planning and conduct of hearing conservation programs, general problems involved in the use of hearing aids. ½ or 1 unit. Prerequisite: Speech 376. STARK.

396. **Differential Diagnosis of Hearing Disorders in Young Children.** Special tests and procedures for the measurement of residual hearing in young children; the effects of complex peripheral and central auditory dysfunctions on communication training; the use of nonwearable amplifiers with young children; practice in clinical techniques. ½ or 1 unit. Prerequisite: Speech 391 and 395, or consent of instructor. STARK.

397. **Measurement of Auditory Perception.** Principles and methods of clinical assessment of auditory perception. Intensive study of measurement techniques for speech perception; applications with clinical clients; survey of current literature and research. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Speech 391. O'NEILL.

398. **Practicum in Audiology.** Observation, practice, and research in diagnosis and rehabilitation of auditory disorders. ½ unit. Prerequisite: Speech 393. STARK.

399. **Experimental Design in Speech Disorders and Audiology.** Review of current research issues: orientation to types of experimental designs and research methods used in speech disorders and audiology. ½ unit.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers work leading to the Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major usually have a bachelor's degree in engineering. Students having a bachelor's degree with a major in mathematics, computer science, engineering physics, engineering science, and similar areas, who have had the equivalent of the undergraduate courses usually required for the bachelor's degree in engineering, however, may also elect to major in theoretical and applied mechanics. Admission requires a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.74 are considered on an individual basis.

Candidates for the Doctor of Philosophy are required to take, in addition to the thesis, at least one-half unit from each of the following areas in the department: (1) applied mathematics, (2) dynamics and vibrations, (3) fluid mechanics, (4) mechanics of solids, (5) materials engineering. A student majoring in one of these areas may elect a second minor in one of the other areas, providing the first minor is outside the department.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science is one unit; for the Doctor of Philosophy, the requirement for a sole minor is four units and for a second minor, two units.

In both Master of Science and Doctor of Philosophy programs, emphasis is placed on both course work and research, the latter being either analytical or experimental. Candidates for the master's degree, as well as for the doctorate, must submit a thesis. The department, as part of the Engineering Experiment Station, conducts many research investigations and makes studies of importance to engineering, manufacturing, and other industrial interests as well as to various governmental agencies. Some of the areas of greatest research activity are properties of materials and the elastic and inelastic behavior of load-resisting members; fracture of metals and composites, including stress corrosion cracking, fracture under sustained loading, low temperature embrittlement, stress rupture in creep, etc.; properties and behavior of plain concrete, reinforced concrete beams, columns, footings, slabs, and frames; creep of metals and of plastics and other inelastic behavior of materials; hydraulics and fluid mechanics including the nature of turbulence, boundary layer theory, etc.; stresses in railway car wheels, rails and bolted and welded rail joints; mechanical vibrations of machines and structures and vibration damping; photoelastic, electric strain gage, and other methods of experimental stress analysis; materials subjected to static and dynamic loads; theoretical and experimental study of wave motion in continuous media; theoretical and experimental analyses of problems in fluid flow, dynamics, theory of elasticity, and theory of plasticity. Controlled environment facilities are available for investigations of plastics, plain and reinforced concrete, and wood.

Major in Applied Mathematics. Graduate students in theoretical and applied mechanics also may major in applied mathematics. The student takes at least one-half of his work in one or more of the following areas: dynamics, fluid mechanics, material engineering, or mechanics of deformable bodies. Further information concerning specific requirements for the major in applied mathematics will be sent upon request to the department.

GRADUATE FACULTY

Professors: T. J. Dolan (Head of Department), A. P. Boresi, C. E. Bowman, M. E. Clark, H. T. Corten, R. A. Eubanks, P. G. Jones, C. E. Kesler, H. L. Langhaar, W. M. Lansford, J. Morrow, J. M. Robertson, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, M. C. Stippes, C. E. Taylor, H. R. Wetenkamp, W. J. Worley.

Associate Professors: A. C. Bianchini, G. A. Costello, R. E. Miller.

Assistant Professors: F. Bauling, D. E. Carlson, R. S. Jensen, J. L. Lott, J. W. Murdock.

COURSES FOR GRADUATES

400. **Seminar in Engineering Mechanics.** There are many special topics in the field of mechanics such as fracture of metals, creep of materials, etc., in mechanics of solids; fluid flow problems such as the nature of turbulence, boundary layer theory, nature and effects of roughness of boundary, effects of free surface; dynamics problems such as vibration of beams with moving loads, the gyroscope, etc. Such special topics as these are covered in this course. Each semester one or more of these topics is selected and announced as the area to be covered in this course during that semester. 1/4 unit. Staff.

412. **Vibration Analysis.** Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; nonlinear systems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311 or equivalent. Jones.

416. **Energy Principles in Engineering Mechanics.** Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy, Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Langhaar, Taylor.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue, and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. 1/2 or 1 unit. Corten, Sinclair.

425. **Mechanics of Inelastic Bodies.** The course presents methods of obtaining relations between loads, deformations, stresses, and strains in various members that are stressed beyond the elastic range. Most applications consider both time-independent and time-dependent (creep) inelastic deformations. Some specific topics are straight and curved beams, columns and beam-columns, fully plastic analysis of statically indeterminate members and structures, torsion of circular and noncircular bars, and torsion-tension of bars of circular cross-section. 1/2 to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321. Sidebottom, Smith.

426. **Stress and Deformation in Engineering Components.** Continuation of Theoretical and Applied Mechanics 321: energy principles, forces and moments in plane and three-dimensional indeterminate members; beams on elastic support; flat plates, thick-walled cylinders, rotating disks, including temperature stresses; contact stresses and deflections; values and significance of stress concentrations. 1/2 to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321 or equivalent. Sidebottom, Smith.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial, are emphasized. The studies involve critical reviews of experimental and analytical investigations. ½ to 1 unit. Prerequisite: Bachelor of Science in engineering. KESLER, LOTT.

428. **Analysis of Nonlinear Systems.** Same as Electrical Engineering 428. Singular points and stability considerations are treated. Graphical and analytical methods including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor. WORLEY.

431. **Theory of Ideal Fluid Flow.** Together with Theoretical and Applied Mechanics 432, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motions are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. 1 unit. Prerequisite: An elementary course in fluid flow; a course in advanced calculus. CLARK, ROBERTSON.

432. **Theory of Flow of Viscous Fluids.** Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially. Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. 1 unit. Prerequisite: An elementary course in fluid flow; a course in differential equations. CLARK, ROBERTSON.

438. **Turbulence.** Starting with the statistical modes of characterizing turbulence, discussion covers statistical theory, energy considerations, and nature of turbulence in typical flows. Laboratory experiments are used to illustrate hot wire technique of turbulence measurements and the structure of turbulence. 1 unit. Prerequisite: Theoretical and Applied Mechanics 432 or equivalent. ROBERTSON.

441. **Applied Analysis in Engineering.** A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

442. **Applied Analysis in Engineering.** Continuation of Theoretical and Applied Mechanics 441. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. LANGHAAR, MILLER.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; Mathematics 341 or equivalent. BORESI, EUBANKS, LANGHAAR, MILLER, TAYLOR.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Langhaar, Stippes.

454. **Theory of Shells.** A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Langhaar.

457. **Classical Elastostatics.** A modern unified treatment of the concepts and techniques developed in the course of investigation of the Cauchy-Navier equations. Emphasis on the interpretation and motivation of ideas and their interrelation for the solution of three-dimensional problems. Topics include the classical boundary-value problems, existence and uniqueness theorems, stress functions and displacement potentials, singular states of stress, extension of Green's method to the equations of elasticity, method of series, and approximation techniques. Course represents a preparation for (1) students interested in the current state of knowledge in classical elasticity, and (2) students intending to do doctoral dissertations in classical elasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent; consent of instructor. Stippes.

458. **Wave Motion in Continuous Media.** An analysis of the dynamics of deformable bodies with a major emphasis on elastic media. Introduces the terminology associated with and the methods for treating such problems. Includes a general discussion of the motion of strings, bars, shafts, plates, and other bodies when subjected to load. Detailed examination of approximations involved is made and their engineering significance is discussed. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311, 314, 451; Mathematics 341, 342, 343, or equivalent. Eubanks, Stippes.

460. **Continuum Mechanics.** Foundations of the general (nonlinear) theories of continuum mechanics. A brief introduction to the tensor calculus is followed by a thorough discussion of the theory of deformation and motion of continua. The stress principle of Cauchy and the basic principles of classical mechanics, i.e., balance of momentum, moment of momentum, and energy, are discussed. A general treatment of constitutive relations is followed by detailed examination of some examples for two particular materials, the elastic solid and the stokesian fluid. 1 unit. Prerequisite: Theoretical and Applied Mechanics 351 or equivalent. Carlson.

462. **Theory of Plasticity.** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading function. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. Sidebottom.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 416 and 451. Costello, Langhaar.

467. **Thermomechanics of Nuclear Reactor Systems.** Same as Nuclear Engineering 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal-shock and thermal stress-wave propagation; current thermo-mechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor. BORESI.

472. **Advanced Photoelasticity.** Theoretical and practical aspects of modern photoelasticity. Topics include: three-dimensional photoelasticity, birefringent coatings, dynamic photoelasticity, photoplasticity, photoviscoelasticity, and photothermoelasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 326 and 451 or consent of instructor. TAYLOR.

493. **Advanced Independent Study (Special Problems).** Analytical or experimental studies in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive study of motion having single degree of freedom; critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 154, or 156 or 211 or 212 and 221.

314. **Advanced Dynamics for Engineers.** Three-dimensional kinematics of a rigid body, general dynamics of a rigid body, moments and products of inertia, kinetic energy, rotation of a rigid body about a fixed axis and about a fixed point, Euler equations of motion, gyroscopic theory; introduction to Lagrange equations; engineering applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 211 or equivalent; Mathematics 341 or 345.

315. **Advanced Dynamics with Applications to Engineering Problems.** General advanced methods of dynamics are discussed. Some emphasis is placed on the behavior of special components of guidance and control systems. Associated engineering problems are treated. Topics: Lagrange equations and Hamiltonian canonical equations; Hamiltonian methods; theory of vibrations; special theory of relativity, gyroscopic compass; gyroscopic stabilizer; modern gyroscopes: astronomical applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 314 or equivalent.

321. **Advanced Mechanics of Deformable Bodies.** Basic concepts of mechanics of deformable bodies and brief review of elementary topics; theory of stress and strain at a point; theories of failure, including failure by fracture; unsymmetrical bending; curved beams; torsion of noncircular sections; energy principles, Castigliano's theorem. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or 224.

326. **Experimental Stress Analysis.** Measurement of stresses or deformations that are of significance in the engineering design of load-resisting members; use of optical, electrical, and mechanical instrumentation, models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 212, 221, and 223 or 224. Theoretical and Applied Mechanics 321 is desirable.

334. **Fluid Mechanics and Advanced Hydraulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions,

cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

335. **Dynamics of Fluids.** An intermediate course in the mechanics of fluids, introducing analytical methods of solution for ideal and real fluids. Potential flow theory, theoretical approaches to viscous flows including boundary-layer theory, and the analysis of compressible flows are indicated. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

346. **Dimensional Analysis and Theory of Models.** The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary-layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. ½ or 1 unit.

351. **Advanced Mechanics of Continuous Media.** General theory of stress; general theory of strain, stress-strain relationships; plane theory of elasticity; advanced topics in bending and torsion. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; a course in differential equations.

392. **Analysis and Synthesis of Problems.** This course emphasizes the rational analysis of comprehensive problems and engineering systems. ½ or 1 unit. Prerequisite: Senior standing in engineering mechanics.

URBAN PLANNING

The Department of Urban Planning offers work leading to the master's degree. Students applying for admission must have a grade-point average of at least 3.75.

Master of Urban Planning. College graduates in liberal arts and sciences as well as architecture, urban planning, civil engineering, and landscape architecture can prepare themselves for careers in city, state, and regional planning.

The graduate program typically requires two years in residence, but a student with an undergraduate degree in urban planning may complete the program in a shorter period.

To qualify for this degree, a student must take (1) the seminar and thesis courses for at least two units, (2) a total of at least six units of urban planning, and (3) at least two additional units to be chosen from the following fields: architecture, civil engineering, economics, geography, landscape architecture, political science, or sociology.

GRADUATE FACULTY

Professors: W. I. Goodman (Chairman of Department), J. M. Heikoff.

Associate Professors: A. Z. Guttenberg, W. B. Hansen, R. Katz, J. L. Kaufman (Visiting), S. Keyes, B. L. Oxman (Visiting).

Assistant Professors: E. C. Freund, J. R. Voss.

Instructor: E. P. Womack.

COURSES FOR GRADUATES

437. **Advanced Urban Planning Studio.** Analysis and synthesis problems related to design and development programming for cities, metropolitan areas, and urban regions. 1 to 2 units. Prerequisite: Urban Planning 337, 338, and 374, or consent of instructor.

487. **Seminar.** ½ unit. Prerequisite: Urban Planning 374.

488. **Urban Planning Research.** Individual and group instruction in the application of professional competences in urban planning to the analysis of urban development problems and to the formulation of approaches to solution of such problems. ½ to 2 units. Prerequisite: Urban Planning 171 or consent of instructor.

499. **Thesis Research.** ½ to 2 units. Prerequisite: Graduate standing in urban planning. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Urban Planning Studio, II.** The theory and development of the planning process as it applies to the study of an existing community, including visual surveys, data collection and analysis, "momentum projections," plan making, and implementation programs. 1 to 1½ units. Prerequisite: Urban Planning 236 or consent of instructor.

338. **Urban Planning Studio, III.** Contemporary theories of urban design and structure; planning and design of new communities; circulation and public facilities systems; studies of alternative patterns of growth. 1 to 1½ units. Prerequisite: Urban Planning 337 or consent of instructor.

351. **History of Urban Planning.** Description and analysis of the development of urbanization and the planning of communities from ancient times to the present, as related to environmental and cultural influences. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

374. **Urban Planning Theory.** An examination of the urban planning function within a theoretical, methodological, institutional, and professional context. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

376. **Planning Analysis.** Research and analytic techniques in urban planning; economic base and employment, population, market analysis; derivation and use of statistical data. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

377. **Comprehensive Planning Procedure.** Design and plan-making techniques in urban planning; land use, circulation and community facilities; the development of the comprehensive general plan. ½ unit. Prerequisite: Urban Planning 171.

378. **Planning Legislation and Administration.** Legal tools of planning, zoning, subdivision regulations; housing codes; methodology and application; administrative procedures; the place of planning in the structure of governments; the capital improvement program. ½ unit. Prerequisite: Political Science 150, 151, or 305, 306, or consent of instructor.

380. **Survey of Regional Planning.** Concepts and procedures for planning of regions: river valley, metropolitan, state, and national planning. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine from a college or university approved by the University of Illinois. If they do not have a veterinary medical degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Areas of specialized study in veterinary medical science include anatomy, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy in Veterinary Medical Science should include in their undergraduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences.

Students planning to work toward the Doctor of Philosophy who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Departmental requirements for the Master of Science or Doctor of Philosophy in Veterinary Medical Science are described in a pamphlet which may be obtained from the office of the Dean of the College of Veterinary Medicine.

GRADUATE FACULTY

Professors: C. A. Brandly (Dean of College of Veterinary Medicine), J. O. Alberts, P. D. Beamer, L. E. Boley, H. W. Hannah, L. E. Hanson, H. J. Hardenbrook, R. D. Hatch, R. H. Kokernot, N. D. Levine, R. P. Link, M. Ristic, L. E. St. Clair, A. G. Schiller, D. Segre, P. H. Silverman, J. Simon, A. M. Watrach.

Associate Professors: D. H. Ferris, W. G. Huber, J. P. Manning, G. T. Woods.

Assistant Professors: F. L. Andersen, H. W. Cox, L. C. Helper, W. L. Myers, H. E. Rhoades, F. E. Romack, A. H. Safanie, A. R. Twardock.

Instructor: Diane K. Normandin.

COURSES FOR GRADUATES

408. **Principles of Hematology.** The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. ½ unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. St. Clair.

415. **Mechanisms of Microbial Infections.** Concepts of host-microorganism relations with emphasis given to the dynamics of microorganisms and pathogenesis of specific infections. 1 unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 332, or equivalent. Hanson, Ristic.

416. **Epizootiology.** Principles and problems of epizootiology with special consideration of the zoonoses; ecology of the host and parasite as related to resistance, adaptation, perpetuation, and distribution; the principles and factors in interference, carrier and latent states, reservoirs and control. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331, Veterinary Medical Science 332, or equivalent, or consent of instructor. Brandly, Kokernot, Levine.

417. **Medical Mycology.** Study of the fungi that cause infections in man and animals; taxonomy, methodology, epidemiology, pathology, and diagnosis. 1 unit. Prerequisite: Microbiology 326, Veterinary Medical Science 332, or equivalent. Rhoades, Watrach.

418. **Concepts and Topics in Immunology.** Newer concepts and theories in the field of immunology, including theories of antibody formation, transplantation immunity, hypersensitivity, and disturbances of the antibody-forming mechanism. Lectures and discussion. ½ unit. Prerequisite: Microbiology 327 or equivalent; consent of instructor. Segre.

425. **Experimental Parasitology.** Same as Zoology 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. Anderson, Levine, Nicholas, Silverman.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Horticulture 440. A study of statistical methods as tools for research. Principles of designing experiments and the meth-

ods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Horticulture 441. A continuation of Veterinary Medical Science 440, moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Veterinary Medical Science 440 or equivalent.

445. **Advanced Macroscopic Pathology.** Concepts and interpretations of gross pathologic changes and the integration of host-parasite reactions. ½ or 1 unit. Prerequisite: Veterinary Medical Science 334 and 335, or equivalent; consent of instructor. ALBERTS, BEAMER.

450. **Advanced Veterinary Pathology.** Advanced study of gross and microscopic pathology of diseases of domestic animals. 1 unit. Prerequisite: Veterinary Medical Science 335 or equivalent. BEAMER.

455. **Comparative Oncology.** A comparative study of the nature of mammalian and avian neoplasms based on general and special methods of tumor identification, classification, and experimentation. Lectures, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 445 and 459, or equivalent. Required course for students majoring in pathology in Department of Veterinary Medical Science. SIMON.

459. **Advanced Correlative Pathology.** Discussion and interpretation of disease processes of domestic animals. Emphasis on the correlation of gross, microscopic and clinico-pathologic findings with alterations of function. ½ or 1 unit. Prerequisite: Veterinary Medical Science 308, 335, 445, 450, or equivalent; consent of instructor. BEAMER, SIMON, WATRACH.

460. **Advanced Veterinary Physiology.** Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Problems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. 1 unit. Prerequisite: Veterinary Medical Science 315, 316, or equivalent; consent of instructor. T. L. HUBER.

461. **Advanced Veterinary Pharmacology.** Evaluation of drugs, pharmacological aspects of biological antagonisms, chemotherapy, antibiotics, chelating agents and chemical biological correlation. ¾ unit. Prerequisite: Consent of instructor. LINK.

463. **Radioisotopes in Biological Research: Principles and Practice.** Same as Animal Science and Biophysics 463. Lectures, demonstrations, and laboratory on the fundamentals of radioisotope procedures and applications in biology and medicine. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

490. **Seminar.** Required of all graduate students whose major is veterinary medical science. ¼ unit. STAFF.

491. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. ½ unit. LEVINE.

492. **Special Problems.** Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Gross Anatomy.** Systematic and topographic study and dissection of the dog. Lectures, discussion, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. ST. CLAIR.

301. **Microscopic Anatomy.** Structure of cellls, tissues, membranes, vessels, lymphoid organs, and the hollow viscera, with special reference to the domestic animal. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. SAFANIE.

302. **Gross Anatomy.** Comparative study and dissection of the domestic animals with special reference to development and adaptation to function. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 300 or consent of instructor. ST. CLAIR.

303. **Microscopic and Developmental Anatomy.** Structure and development of organs and systems with comparison in different domestic animals. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 301 or consent of instructor. SAFANIE.

308. **Histochemistry.** Methods used in histochemical and histological analysis in animals. Lectures, discussions, demonstrations, and laboratory. ½ or 1 unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. NORMANDIN.

315. **Physiology.** Physiochemical phenomenon, blood and lymph, circulation, respiration, digestion, absorption, and excretion in domestic animals and birds. Lectures, recitations, demonstrations, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. LINK.

316. **Physiology.** Body fluids and their regulation; urine secretion; acid-base balance; physiology of renal disease in animals; metabolism; heat regulation; liver and biliary system; muscular and peripheral nervous system. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. LINK.

317. **Physiology.** Central nervous system and special senses including vision, taste, smell, and hearing; endocrine organs and their secretion; reproduction and growth. Lectures, demonstrations, and laboratory. ¾ unit. Prerequisite: Veterinary Medical Science 316 or consent of instructor. LINK.

318. **Pharmacology.** General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures, discussions, demonstrations, and laboratory. 1 unit. Prerequisite: Credit or registration in Veterinary Medical Science 315 and 316; consent of instructor. W. G. HUBER.

320. **Pharmacology and Toxicology.** Principles of drug action and an analysis of action of chemical agents on living organisms including intoxications of domestic animals. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Veterinary Medical Science 318 or consent of instructor. W. G. HUBER.

332. **Veterinary Microbiology and Immunology.** Lectures, discussions, and laboratories dealing with mechanisms of infection and resistance and the properties, pathogenesis, and control of viral infection of domestic and wild animals. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331 or equivalent; consent of instructor. HANSON, MYERS.

333. **Protozoan and Arthropod Parasites.** Protozoan and arthropod parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. LEVINE.

334. **General Pathology.** The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasia. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses in histology, parasitology, physiology, and microbiology totaling twenty-five semester hours; consent of instructor. WATRACH.

335. **Special Pathology.** Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and labo-

ratory. 1 unit. Prerequisite: Veterinary Medical Science 334 or equivalent; consent of instructor. BEAMER.

336. **Helminth Parasites.** Helminth parasites affecting domestic animals and man. Lectures, discussion, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. LEVINE.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. KENDEIGH, LEVINE, SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Sociology 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. KENDEIGH, LEVINE, SHIMKIN, STAFF.

392. **Special Problems.** Individual research on a special problem chosen in consultation with the instructor and department head. ½ unit. May be repeated for a total of one unit. Prerequisite: Registration in veterinary medical curriculum with grade-point average of 3.5 or above. STAFF.

ZOOLOGY

See descriptions and course listings under Life Sciences, page 232.

UNIVERSITY OF ILLINOIS

Where to Write

ADMISSION
Office of Admissions and Records
100a Administration Building, Urbana 61801
or
The Graduate College
330 Administration Building, Urbana 61801

CHICAGO CIRCLE
Dr. R. Curtis Retherford, Associate Dean of the Graduate College
P.O. Box 4348, Chicago 60680

EMPLOYMENT (Hourly)
Director, Student Employment
1 Student Services Building, Champaign 61820

EXTRAMURAL CLASSES
Division of University Extension
101 Illini Hall, Champaign 61820

FELLOWSHIPS, ASSISTANTSHIPS, OTHER FINANCIAL AID
The Graduate College
330 Administration Building, Urbana 61801
or the prospective major department

FOREIGN STUDENTS (Passport, Visa Assistance)
Director, Office of Foreign Student Affairs
314 Student Services Building, Champaign 61820

HOUSING
Director, Housing Division
420 Student Services Building, Champaign 61820

MEDICAL CENTER (Medical and Dental Sciences, Pharmacy)
Dr. Milan V. Novak, Associate Dean of the Graduate College
P.O. Box 6998, Chicago 60680

MOTOR VEHICLE AND BICYCLE REGISTRATION
Motor Vehicle Division
101 North Mathews Avenue, Urbana 61801

PUBLICATIONS
Graduate College Catalog; Time Table; Calendar;
Financial Aid for Graduate Students;
Saturday, Late Afternoon, and Evening Classes for Teachers
The Graduate College
330 Administration Building, Urbana 61801

DEPARTMENTAL BROCHURES
The prospective major department

SERVICES FOR PERMANENTLY PHYSICALLY HANDICAPPED STUDENTS
Division of Rehabilitation—Education Services
Rehabilitation-Education Center, Champaign 61820

VETERANS
Veterans Educational Benefits
100a Administration Building, Urbana 61801

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Ref.

1967–1968 CENTENNIAL EDITION

ERSITY OF ILLINOIS GRADUATE COLLEGE

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IVERSITY OF ILLINOIS GRADUATE COLLEGE

ANA DEPARTMENTS / 1967-1968 / UNIVERSITY OF ILLINOIS BULLETIN

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1966-1967

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Zoology	Paul H. Silverman

*Awards master's degree only.
†Awards master's degree in management only.

CALENDAR OF THE GRADUATE COLLEGE

Note: Information pertaining to foreign language examinations in French and German during the first and second semesters of 1967-1968 and the summer session of 1968 will be available by October, 1967.

Summer Session, 1967

June 19, Mon.-June 21, Wed.	Registration of graduate students. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 15.
June 20, Tuesday	Instruction begins.
June 30, Friday	Application to take French examination on July 14 will not be accepted in Graduate College Office after this date.
July 4, Tuesday	Independence Day (holiday).
July 7, Friday	Applications to take German examination on July 21 will not be accepted in Graduate College Office after this date.
July 14, Friday	Applications to take Russian examination on July 28 will not be accepted in Graduate College Office after this date.
July 14, Friday evening	French examination
July 21, Friday evening	German examination.
July 28, Friday evening	Russian examination.
August 10, Thursday	No names will be added to the August graduation list after this date.
Aug. 11, Fri.-Aug. 12, Sat.	Summer session examinations.
August 14, Monday	Last day for candidates for the master's degree in August to deposit theses.
September 8, Friday	Last day for candidates for the doctoral degree in October to submit theses and abstracts to Graduate College Office for approval of format.
September 22, Friday	Last day to file application for the master's degree in October.
September 22, Friday	Last day for candidates for the master's degree in October to deposit theses.
September 23, Saturday	Last day for finals for the doctoral degree in October.
September 29, Friday	Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1967

August 2, Wednesday ..... Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1967.

August 30, Wednesday ..... Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1967.

First Semester, 1967-1968

August 2, Wednesday ..... Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1967.

August 30, Wednesday ..... Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1967.

Sept. 14, Thurs.-Sept. 16, Sat. to noon ..... Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, September 16. There will be no registration on Saturday, September 23.)

September 16, Saturday ..... Last day for registration without payment of late registration fine.

September 18, Monday ..... Instruction begins.

October 13, Friday ..... Applications to take Russian examination on October 27 will not be accepted in Graduate College Office after this date.

October 27, Friday evening ..... Russian examination.

October 30, Monday ..... Last day for adding a course to program.

November 18, Saturday ..... Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

November 22, Wednesday, 1 P.M. .. Thanksgiving vacation begins.

November 27, Monday, 1 P.M. .... Thanksgiving vacation ends.

December 1, Friday ..... Applications to take Russian examination on December 15 will not be accepted in Graduate College Office after this date.

December 15, Friday evening ..... Russian examination.

December 22, Friday, 1 P.M. ..... Christmas vacation begins.

1968

January 3, Wednesday, 1 P.M. .... Christmas vacation ends.

January 5, Friday ..... Last day for candidates for the doctoral degree in February to submit theses and abstracts to Graduate College Office for approval of format.

January 12, Friday ..... No names will be added to the February graduation list after this date.

Jan. 15, Mon.-Jan. 23, Tues. ..... Semester examinations.

January 15, Monday ..... Last day for candidates for the master's degree in February to deposit theses.

January 22, Monday ..... Last day for finals for the doctoral degree in February.

January 29, Monday ..... Last day for candidates for the doctoral degree in February to deposit theses and abstracts.

Second Semester, 1967-1968

Feb. 1, Thurs.-Feb. 3, Sat. to noon ..... Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, February 3. There will be no registration on Saturday, February 10.)

February 3, Saturday ..... Last day for registration without payment of late registration fine.

February 5, Monday ..... Instruction begins.

February 15, Thursday ..... Last day for application for fellowships for 1968-1969.

March 1, Friday ..... Earliest date to apply for National Defense Student Loan funds for 1968-1969.

March 1, Friday ..... Applications to take Russian examination on March 15 will not be accepted in Graduate College Office after this date.

March 15, Friday evening ..... Russian examination.

March 18, Monday ..... Last day for adding a course to program.

March 23, Saturday ..... Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

April 6, Saturday noon ..... Spring vacation begins.

April 15, Monday, 1 P.M. ..... Spring vacation ends.

April 26, Friday ..... Applications to take Russian examination on May 10 will not be accepted in Graduate College Office after this date.

April 26, Friday ..... No names will be added to the June graduation list after this date.

May 3, Friday ..... Honors Day. Classes dismissed at noon.

May 10, Friday evening ..... Russian examination.

May 13, Monday ..... Last day for candidates for the doctoral degree in June to submit theses and abstracts to Graduate College Office for approval of format.

May 24, Friday ..... Last day for candidates for the master's degree in June to deposit theses.

May 27, Monday ..... Last day for finals for the doctoral degree in June.

May 27, Mon.-June 5, Wed. ..... Semester examinations.

May 30, Thursday ..... Memorial Day (holiday).

June 1, Saturday ..... Last day to apply for National Defense Student Loan funds for 1968-1969.

June 3, Monday ..... Last day for candidates for the doctoral degree in June to deposit theses and abstracts.

June 15, Saturday ..... Commencement exercises.

Summer Session, 1968

June 17, Mon.-June 18, Tues. .... Registration of graduate students. (Authorization cards distributed on alphabetical basis. Registration schedule available by May 13.)

June 18, Tuesday ..... Instruction begins.

July 4, Thursday ..... Independence Day (holiday).

July 12, Friday	Applications to take Russian examination on July 26 will not be accepted in Graduate College Office after this date.
July 26, Friday evening	Russian examination.
August 8, Thursday	No names will be added to the August graduation list after this date.
August 8, Thursday	Last day for candidates for the master's degree in August to deposit theses.
Aug. 9, Fri.—Aug. 10, Sat.	Summer session examinations.
August 30, Friday	Last day for candidates for the doctoral degree in October to submit theses and abstracts to Graduate College Office for approval of format.
September 20, Friday	Last day to file application for the master's degree in October.
September 20, Friday	Last day for candidates for the master's degree in October to deposit theses.
September 21, Saturday	Last day for finals for the doctoral degree in October.
September 30, Monday	Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1968

July 31, Wednesday	Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1968.
August 28, Wednesday	Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1968.

The Graduate College

The University of Illinois has its oldest and largest campus at Urbana-Champaign, a community of 95,500 located 128 miles south of Chicago. Originally, it was established as the Illinois Industrial University, on the basis of the Land Grant College Act, by Governor R. J. Oglesby in 1868. The University opened its door with three full-time faculty members and fifty students. Now, one hundred years later, the total enrollment in the various branches of the University—the Graduate College and undergraduate colleges at Urbana, the graduate division and professional colleges at the Medical Center, Chicago, and the undergraduate colleges at Chicago Circle—exceeds 45,000. The combined faculty and staff includes the full-time equivalent of more than 14,700 members.

The Graduate College of the University of Illinois at Urbana offers instruction leading to advanced degrees in over one hundred fields of learning. Graduate enrollment currently exceeds 8,000 students who represent every state and seventy foreign countries. Today, a graduate faculty of 1,500 implements the University of Illinois Statutes which charge the Graduate College with the responsibility "to safeguard and promote standards of graduate work on the Urbana-Champaign campus and at the Medical Center, Chicago, and to promote and assist in the development of research in all fields."

Graduate work in the medical and dental sciences and in pharmacy is offered in Chicago at the University's Medical Center. Inquires concerning these programs should be directed to Dr. Milan V. Novak, Associate Dean of the Graduate College, University of Illinois at the Medical Center, 1853 West Polk Street, Chicago (P.O. Box 6998, Chicago 60680). It is also expected that by the fall of 1967 graduate programs in a number of disciplinary areas will be available at the University's Chicago Circle. Information may be obtained by writing to Dr. R. Curtis Retherford, Associate Dean of the Graduate College, University of Illinois at Chicago Circle, 2037 University Hall, Chicago (P.O. Box 4348, Chicago 60680).

Graduate instruction offered at the Urbana campus is listed by areas on pages 3 to 5 and is described in detail within the departmental listings, arranged alphabetically in this catalog.

The general requirements for admission and the degree requirements established by the Graduate College are described in this introductory section. All candidates for degrees must meet these requirements as well as those specified by the major departments within the departmental listings.

UNIVERSITY RESOURCES

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 4,083,634 volumes, all but about 332,000 of them located in Urbana. The remainder are held by the Library of Medical Sciences in Chicago and the library at Chicago Circle.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 560,520 pamphlets, 327,603 maps and aerial photographs, and 300,500 music scores and parts. More than 20,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archaeology; sixteenth- and seventeenth-century English literature, especially the Milton-Shakespeare period; eighteenth-twentieth century English literature, American humor and folklore; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

In the social sciences, the Library's holdings are significant for western United States history, Abraham Lincoln and the Civil War, Latin American history of the Revolutionary period, Italian history, medieval and modern European history, German history for 1830-1900, Irish history, international law and relations, political science, law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a general catalog of more than 5,000,000 cards, a union catalog of titles owned by about two dozen major American and foreign libraries; printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained.

Following are the principal collections in the main library building: Browsing Room, Classics, Commerce, Education and Social Science, English, History and Philosophy, Human Relations Area Files, Library Science, Map and Geography, Modern Language, Newspaper, Physical Education, Rare Book Room, and Undergraduate Library.

Elsewhere on the campus are departmental libraries for the following fields: Agriculture, Architecture and Fine Arts, Biology, Ceramics, Chemistry, City Planning, Engineering, Geology, Home Economics, Journalism and Communications, Labor and Industrial Relations, Landscape Architecture, Law, Mathematics, Music, Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are the general bookstacks, housing about 2,000,000 volumes, and over 300 carrels in the bookstacks, assigned to individuals engaged in extended study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Digital Computers. See Department of Computer Science, page 123.

Electron Microscope Laboratory. The Electron Microscope Laboratory, located in the basement of Bevier Hall, is a central facility for instruction and research in behalf of all University departments. It is equipped with a Siemens Elmiskop I, an Hitachi HS-6, and RCA models EMU-3C, EMU-2C, EMU-2F, EMT, and EMC electron microscopes. Ancillary equipment includes three ultramicrotomes, two shadowcasters, an RCA electron diffraction unit, and two complete photographic darkrooms and general facilities.

The instructional program consists of the following courses: Biology, Chemistry, or Zoology 423, Electron Microscopy; Biology, Chemistry, or Zoology 429, Electron Microscopy Laboratory; Zoology, Entomology, Microbiology, or Physiology 430, Biological Ultrastructure; and seminars and special workshops. The facilities are available for research conducted by qualified faculty-staff members and graduate students.

Physical Environment Unit. The facilities of the Physical Environment Unit provide unique opportunities for pursuing interdisciplinary researches on the responses of biological systems to stresses imposed by the physical environment. An altitude chamber accommodating six human beings permits simulation of altitudes up to 45,000 feet. Air temperature and humidity may be controlled in this chamber to permit investigation of the combined stresses of low environmental pressure and heat or cold. Additional controlled environment rooms provide flexible

areas where special test facilities may be installed. All departments and divisions of the University needing closely controlled environmental conditions for research or instructional work are encouraged to utilize the special skills and equipment available in the Unit. Although primarily designed for studies with human subjects and animals, engineering and physical science projects are not excluded, if space is available.

Radiocarbon Laboratory. The Radiocarbon Laboratory is an all-University facility for graduate training and research involving the use of the tracer technique with carbon-14 and/or tritium. It is equipped with liquid scintillation spectrometers, vibrating reed electrometers, gas counters, radio-gas chromatography units, high vacuum systems, combustion set-up, and auxiliary radiochemical equipment.

A prerequisite for research in the Laboratory is the carbon-14 course, Chemistry and Animal Science 496, which emphasizes experimental techniques employed in the synthesis, degradation, isolation, establishment of purity, and assay of radioactive carbon compounds. Members of the staff present this course one semester each year.

Social and Cultural Facilities

Many special programs are planned to celebrate the University's Centennial year beginning February 28, 1967, and extending to March 11, 1968. Every year, however, students at the University of Illinois have a wide choice of activities and facilities available to them. Campus events announced in a weekly calendar include musical programs, lectures, University forums, campus and traveling theatrical productions, weekend movies and dances, and fine arts and scientific exhibitions.

The Krannert Art Museum provides galleries for displaying the University's permanent collection of art works and for presentation of other exhibitions. A University Festival of Contemporary Arts, held every two years, includes special events and exhibits in the areas of art, architecture, landscape architecture, urban planning, drama, motion picture, literature, printing, dance, and music. Illini Union, the campus social center, has lounges, dining facilities, and recreational and meeting rooms available to students and faculty.

ADMISSION

General Requirements

It is recommended that prospective students apply for admission about two months before the beginning of the term in which they expect to

enroll. Applications for admission or readmission, including all supporting documentation, *must be submitted* by domestic students at least two weeks prior to registration or by foreign students at least six weeks prior to registration.

A nonrefundable deposit of $30.00 on tuition and fees is required of all *new and readmitted domestic graduate students and all foreign students who are presently residing in the United States.* This deposit should not be sent until requested by the University. Graduate students assured of the award of a fellowship, assistantship, or tuition and fee waiver are permitted to confirm their intention to enroll without payment of the advance deposit.

Admission forms may be obtained from the Office of Admissions and Records, 100a Administration Building, or from the Graduate College, 330 Administration Building. Foreign students should request admission by letter (see page 21).

An applicant is favorably considered for admission to the Graduate College if (1) he is a graduate of an institution awarding a baccalaureate degree comparable to that granted by the University of Illinois; (2) he is adequately prepared for advanced study as demonstrated by his previous program of study and his scholastic record; and (3) he is recommended for admission by his major department and the Dean of the Graduate College.

The prerequisites for advanced work in the various fields of specialization are listed in the departmental sections of this catalog. Also listed are the scholastic grade-point average requirements which must be met before an application for admission is considered. The scholastic average is expressed in terms of a five-point scale (A=5.0; B=4.0; etc.).

The grade-point average of an applicant for master's candidacy is computed from the last sixty semester hours of course work completed, including undergraduate and any graduate courses taken. An applicant for post-master's and doctoral candidacy who has earned a master's degree or at least thirty-two semester hours of graduate study is considered for admission on the basis of two scholastic grade-point averages: one average for the last sixty semester hours of undergraduate study and the other for all graduate course work completed to date.

A department's recommendation with respect to the admission of an applicant is not based solely on the scholastic average. Therefore, not all who meet the scholastic requirements can be admitted.

Physical Examination

Each new student proposing to enroll in the University of Illinois at Urbana-Champaign or at the Chicago Circle campus for a full semester

is required, before completion of his registration, to present adequate evidence of satisfactory physical and mental health as determined by the Director of Health Services of the University.

Part-time graduate students enrolling for one unit, or five hours, or less, are not required to have a physical examination except in those instances when the Director of Health Services considers the physical examination, in addition to the required tuberculin test, advisable for the protection of the health of other students.

Former and continuing students in the University of Illinois may also be required to present adequate evidence of satisfactory physical and mental health prior to readmission or registration and continuation in the University. All former students re-entering after an absence of one semester or longer are required to have the tuberculin test as a condition of registration. All students who have lived abroad for an academic year or its equivalent are required to have a complete physical examination when returning to reregister in the University.

A new student enrolling in the summer session is required to take the tuberculin test administered by the Health Service without charge as a part of the registration procedure, but is not required to take the physical examination until such time as he enrolls for a full semester. Anyone who has had a normal chest film within the past six months, and presents evidence thereof, is excused from the tuberculin test.

A complete physical examination, including chest X-ray, performed by the University Health Service, is required of all foreign students prior to receipt of a permit to enter the University, including those foreign students whose first enrollment at the University of Illinois is in the summer session. This examination is given by the Health Service without charge.

Detailed explanatory material and medical forms for reporting the pre-entrance examination are forwarded to each student who receives a permit to enter.

Graduate Study by Seniors at the University of Illinois

A senior at the University of Illinois whose academic average for his junior and senior work is 4.0 or above may apply for admission to the Graduate College if he is *within five hours* of his baccalaureate degree. If he is *within ten to six hours* of that degree he may apply to take some work for graduate credit. Forms describing the procedure to be followed are available at the Graduate College Office.

Readmission

A former student who has not registered for one or more semesters must file an application for readmission. This form should be submitted to the Office of Admissions and Records as early as possible and not later than two weeks before the beginning of the term in which he expects to register. A nonrefundable deposit of $30.00 on tuition and fees is required of all students seeking readmission, unless they have been assured of the award of a fellowship, assistantship, or tuition and fee waiver.

Foreign Applicants

A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Office of Admissions and Records, 100a Administration Building, Urbana, Illinois 61801. He should enclose with his initial inquiry for admission, copies of his complete academic records which have been officially certified by the educational institutions he has previously attended. These official records should include a listing of all final degrees, diplomas, or certificates awarded.

An authenticated English translation must accompany all documents that are in a language other than English.

A prospective applicant must also provide the following information: full legal name; address to which reply should be mailed; place and date of birth; name of the country of which he is now a citizen; marital status; form of permanent physical handicap, if any; the subject in which he wishes to specialize; native language; whether he wishes to be a candidate for an undergraduate or graduate degree; amount in United States dollars available for support, the source of income, and the length of time this support is guaranteed; a complete chronological list of all elementary and secondary schools, and colleges attended, with the exact dates of attendance, and diplomas, certificates, or degrees received; if he is not attending school, his occupation since leaving school; the date he plans to enter.

Because it is not advisable to undertake a graduate program at the University of Illinois without adequate competence in the English language, all applicants whose native tongue is not English are required to take the Test of English as a Foreign Language (TOEFL). Applicants may make arrangements to take this test by writing to the Educational Testing Service (ETS), Princeton, New Jersey, United States of America, and requesting that they be tested in their home country. Applicants must request that ETS send a copy of their test results to the

Office of Admissions and Records. Upon receipt of satisfactory English test results and the completed application form, the Office of Admissions and Records issues documents admitting the student to the Graduate College, including an appropriate certificate to apply for a visa to enter the United States.

Military Deferment

The Selective Service System through the local board determines the student's deferment status. Generally, the following criteria are used as a guide for deferment:

(1) Certification from the baccalaureate institution that the student graduated in the upper quarter of his class, or achievement on the Selective Service Qualification Test with a score of eighty or above.

(2) Verification from the Graduate College that the student is satisfactorily pursuing a full-time program of study. A full-time program involves (a) three or more units of graduate study, (b) a program of both graduate and undergraduate courses equivalent to twelve or more semester hours, or (c) two units of graduate study and an appointment as a teaching or research assistant for not less than one-half time.

It is the student's responsibility to initiate the appropriate request or form that will enable the University to send accurate information to his local board. A prospective student, prior to the first registration period, should request the Office of Graduate and Foreign Admission, 100a Administration Building, to notify his local board of his admission status.

A student who is registered should obtain a Status Form for Graduate Students Seeking Deferment from his major department or the Graduate College. This form must be completed by the student, certified by the executive officer of the major department, and filed with the Office of Admissions and Records, 69 Administration Building, at the times shown below:

(1) When the student first registers and every September thereafter.

(2) When a "change of program" is initiated which will reduce the student's program to less than three units or the equivalent (twelve semester hours).

(3) When the student's degree objective or anticipated degree date changes.

Local boards expect a student to complete requirements for a master's degree within two years and the doctoral requirements within five years of his first registration as a graduate student. If a student's program of study must be extended, for justifiable reasons, the major department may send a letter of explanation to the local board for its consideration.

The University may inform and justify, but has no control over decisions made by the Selective Service System. A student who is reclassified by his board and who wishes to appeal the reclassification should immediately notify his local board in writing that he wishes to appeal. The right to appeal is forfeited ten days after the reclassification date.

FEES AND EXPENSES

Expenses

Although personal expenses may vary according to the individual needs and benefits, the following estimates indicate the average basic living costs for single students. Cost of weekly board ranges from $20.00 to $25.00, single rooms in private student houses from $35.00 to $55.00 a month, and double rooms from $35.00 to $50.00 a month for each person. In some cases, apartments are shared and the monthly costs per person can be from $50.00 to $60.00, plus the cost of utilities. Graduate halls operated by the University offer single rooms at rates ranging from $424.00 to $518.00 for the academic year and double rooms at rates ranging from $360.00 to $486.00 per person for the same period. A board contract may be purchased for one semester at a rate of approximately $246.00.

Tuition and Fees

Tuition and other fees, as indicated below, are payable in full when the student registers, unless the installment plan of payment is elected. An additional charge of $2.00 is made for this privilege.

SEMESTER

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 10 hours Above 2½ units		Above 5 to 10 hours Above 1¼ to 2½ units		Above 0 to 5 hours Above 0 to 1¼ units	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 85.00	$375.00	$60.00	$265.00	$35.00	$155.00
Service Fee[1]	40.00	40.00	25.00	25.00	10.00	10.00
Hospital-Medical-Surgical Insurance Fee[2]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$135.00	$425.00	$95.00	$300.00	$55.00	$175.00

EIGHT-WEEK SUMMER SESSION

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 5 hours Above 1 1/4 units		Above 2 1/2 to 5 hours Above 3/4 to 1 1/4 units		Above 0 to 2 1/2 hours Above 0 to 3/4 unit	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 45.00	$190.00	$30.00	$130.00	$20.00	$ 80.00
Service Fee[1]	20.00	20.00	15.00	15.00	5.00	5.00
Hospital-Medical-Surgical Insurance Fee[2,3]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$75.00	$220.00	$55.00	$155.00	$35.00	$ 95.00

NONCREDIT COURSES

Students (except those holding exemptions) who register in noncredit courses pay tuition and fees as follows:

(1) Persons who register *on campus* for doctoral thesis research (499) only, without credit, are charged the following:

SEMESTER:

Tuition $10.00
Service Fee 10.00
Hospital-Medical-Surgical Insurance Fee 10.00

EIGHT-WEEK SUMMER SESSION:

Tuition $10.00
Service Fee 5.00
Hospital-Medical-Surgical Insurance Fee 10.00

(2) Persons who register for doctoral thesis research (499) *in absentia* without credit are charged only a tuition fee of $10.00
(Those registered *in absentia* for credit pay the regular tuition, resident or nonresident, as applicable.)

[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off-campus are exempt from the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of this fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed waiver and assumption of responsibility is required. Persons registered for thesis research *in absentia* are not assessed this fee.

[3] If insurance coverage for the period between the close of the summer session and the beginning of the first semester is not desired, $5.00 will be refunded if requested in writing prior to the final date established for full refund of fees.

(3) Persons who register in noncredit seminars, either alone or in addition to other courses ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(4) Persons who register in noncredit courses in addition to credit courses pay ..... *No additional charge*
(If taken alone, registrations in noncredit courses other than thesis research and seminars are assigned to Range III.)

(5) University employees who register at the request of their department in noncredit courses especially established to improve the work of the employee ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(6) Persons wishing to attend a campus course as a visitor only (special permit required) pay for each course a fee of $15.00

Residence Classification

The residence classification of an applicant is determined on the basis of information given on his application and other credentials. Fees are assessed in accordance with this decision. If the student believes he has a legitimate cause for change of status, he may, by petition, on a form provided by the Office of Admissions and Records, request a change. Petitions are considered *within thirty days* from the date designated in the official University Calendar as that upon which instruction begins for the academic period for which the fee is payable. However, if the nonresident fee was not assessed on or prior to that date, the claim for refund may be filed *within thirty days* after the nonresident fee was assessed and the student was given notice of its assessment. Tuition and fees will not be adjusted for that academic term if the petition is not filed within these time limits. Additional evidence to substantiate a request may be required. If the student expects to ask for a change of residence classification, it is advisable for him to request the adjustment be made prior to the registration period.

In the event a student who claims he is a resident student is dissatisfied with an adverse ruling of the Director of Admissions and Records, he may obtain a review of such decision by the Legal Counsel of the University by filing a written request with the Director of Admissions and Records within twenty days after he has been notified of the ruling.

Further information concerning residency may be secured by contacting the Director of Admissions and Records, 178 Administration Building, Urbana, Illinois 61801. A brochure entitled *Regulations Governing Assessment of Resident or Nonresident Student Fees* is also available.

Special Fees

Below is a partial list of special fees pertaining to graduate students. A complete schedule of tuition and fees may be obtained from the Office of Admissions and Records, 69 Administration Building.

Late Registration Fine—$15.00. All students, whether on appointment or not, who complete registration for courses on campus after the close of the regular registration, are subject to this fine in addition to the tuition and fees. A student's registration is not complete until his tuition and fees have been paid in full, or he has made arrangements with the Bursar's Office for deferment of payment. Students who register late in any term pay the same tuition and fees as students who register at the beginning of the term.

Change of Program Fee—$1.00. This fee is charged for every course change slip issued at the request of the student after the completion of registration.

Exemptions. A student may be exempted from one or more of the usual charges if he qualifies under the following conditions:

TUITION IS WAIVED FOR:

(1) Holders of tuition waiver scholarships.

(2) All academic employees of the University or of allied agencies on appointment for at least 25 per cent but not more than 67 per cent of full-time services.

(3) All permanent nonacademic employees of the University or allied agencies on appointment for at least 25 per cent of full time who register in University courses in Range II or III.

(4) Holders of graduate tuition and fee waivers awarded by the Graduate College.

(5) Holders of grants or contracts from outside sponsors which provide payments to cover the total costs of instruction.

(6) Cooperating teachers and administratiors who receive assignment of practice teachers. (Exemption is provided in one semester, quarter, or summer session for each semester or quarter of assignment within the same calendar year — September through August.)

(7) Persons registered in noncredit seminars only.

(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.

(9) Academic staff members emeriti.

NONRESIDENT PORTION OF TUITION (IF SUBJECT TO PAYMENT OF TUITION) IS WAIVED FOR:

(1) All staff members (academic, administrative, or permanent non-academic on appointment for at least 25 per cent of full time with the University or the allied agencies.
(2) The faculties of state-supported institutions of higher education in Illinois.
(3) The teaching staff in the private and public elementary and secondary schools in Illinois.
(4) The spouses and dependent children of those listed in items 1 and 2 above. (Dependent children are those who qualify as dependents for federal income tax purposes.)
(5) Persons actively serving in one of the Armed Forces of the United States who are stationed and present in the state of Illinois in connection with that service.
(6) The spouses and dependent children of those listed in item 5 above, as long as they remain stationed, present, and living in this state.

Vehicle Registration. All resident students enrolled in the Graduate College who have a motor vehicle in their possession are required to register this vehicle with the Motor Vehicle Division. The fee assessed is $5.00, except that graduate students holding fellowships or teaching or research appointments for at least one-half time have the option of securing at no cost a registration permit with reduced parking privileges.

Student motor vehicle registrations are effective from September 1 to September 1 of each year with all interim registrations (including new, transfer, and returning students) being effective until the following September 1. All motor vehicles in possession of students must be registered within one school day of the acquisition of such vehicles.

The Motor Vehicle Division requires the registration of all motorcycles, motor scooters, and motor bicycles. The fee for such registration is $3.00 per year.

Bicycles also must be registered with this Division. No fee is charged for such registration.

Questions relating to vehicle regulations should be referred to the Motor Vehicle Division, 101 North Mathews Avenue, Urbana, Illinois 61801.

Assessments and Exemptions

Assessments. For fee assessment purposes, a staff appointment must require service for not less than three-fourths of the term. This is

interpreted as a minimum of three and one-half months in a semester, nine weeks in a quarter, and six weeks in an eight-week summer session. Staff tuition and fee privileges do not apply to students employed on an hourly basis in either an academic or nonacademic capacity, or to persons on leave without pay.

For fee assessment purposes, a *permanent* nonacademic employee is defined as a person who has been assigned to an established, permanent, and continuous non-academic position and who is employed for at least 25 per cent of full time.

University employees appointed to established Civil Service positions whose rate of pay is determined by negotiation, prevailng rates, union affiliation, etc., are not considered as paid on a hourly basis and are entitled to the same tuition and fee privileges accorded to other staff members under the regulations.

Any student who resigns his staff appointment, or whose appointment is cancelled before rendering service for at least three-fourths of the term, becomes subject to the full amount of the appropriate tuition and fees for that term unless he withdraws from his University classes at the same time the appointment becomes void. Such students are not assessed tuition and fees for that term if they file clearance for graduation within one week after the appointment becomes void.

For those listed in items 1 through 4 on page 26, who are eligible for such waiver in the final term of the academic year, except as indicated under summer session below, this privilege is also extended to the summer session immediately following.

SERVICE FEE IS WAIVED FOR:

(1) All staff members of the University or allied agencies on appointment for at least 25 per cent of full time.
(2) Holders of graduate tuition and fee waivers awarded by the Gradute College.
(3) Students registered *in absentia.*
(4) Students registered in courses taught off campus.
(5) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(6) Cooperating teachers and administrators described under tuition waivers, item 6 on page 26.
(7) Persons registered in noncredit seminars only.
(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

HOSPITAL-MEDICAL-SURGICAL INSURANCE FEE IS WAIVED FOR:

(1) Students presenting evidence of equivalent coverage upon approval of a petition presented to the University Insurance Office not later than the final day established for full refund of fees.
(2) Persons registered for thesis research *in absentia.*
(3) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(4) Students for whom this fee has been assumed by the Graduate College.
(5) Persons registered in noncredit seminars only.
(6) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.

SUMMER SESSION TUITION AND FEES ARE WAIVED FOR:

(1) Students holding academic appointments to the close of the final term of an academic year either as employees or fellows, and for whom tuition and/or fees have been provided through waiver or through cash payment by an outside agency, are entitled to a waiver of the same kinds of tuition and fees for the summer session immediately following, provided they hold no appointments during that summer session.
(2) Students holding summer session appointments as fellows or as employees are subject to such tuition and fees as would be assessed in accordance with the principles expressed above.

Advance Deposit

Each new, readmitted, and advance enrolled continuing student (except foreign students who, at the time of application, are residing outside the United States, and certain others specifically exempted) who wishes to register for a fall semester is required to make an advance deposit in order to secure the place reserved for him. New and readmitted students wishing to enroll in the spring semester are also required to make an advance deposit.

This is not an additional cost for attending the University but is applied to each student's tuition and fees in the semester for which he is approved. In case the student fails to enter the University in that semester, the deposit may not be applied toward any future registration. The deposit should not be sent until requested by the University. It is nonrefundable except in very special cases.

The following graduate students may confirm their intentions to register without payment of the advance deposit:

(1) All new foreign students residing outside the United States at the time of application.
(2) New, readmitted, and advance enrolled continuing graduate students, holding a fellowship, academic or nonacademic staff appointment, or graduate tuition and fee waiver.
(3) New, readmitted, and advance enrolled continuing graduate students who receive a financial award from an agency outside the University, and whose complete tuition and service fee are billed to the agency by the Bursar.
(4) Doctoral candidates who have passed the preliminary examination.

Housing

The University has residence facilities in Arthur Hill Daniels Hall and Stuart Pratt Sherman Hall, two separate residence hall complexes for approximately 1,000 single graduate students, both men and women. Semester contract food service in undergraduate dining halls can also be arranged. In addition, the University provides a limited number of apartments for married students, with priority in assignment given to part-time research and teaching assistants.

Applications for accommodations in the University graduate residence halls or the University-owned apartments for married students may be obtained from the Housing Division, 420 Student Services Building, Champaign, Illinois 61820. The Housing Division also maintains a courtesy list of private apartments and rooms available in homes in the community. Office hours are from 8:00 a.m. to 12:00 noon and 1:00 to 5:00 p.m. Monday through Friday, and from 9:00 a.m. to 12:00 noon each Saturday. During the weekend prior to registration, office hours also are maintained from 1:00 to 4:00 p.m. Saturday and 10:00 a.m. to 12:00 noon and 2:00 to 4:00 p.m. Sunday. University offices are not open on national holidays.

Installment Plan for Payment of University Fees and Housing Charges

Students registered on the Urbana-Champaign campus are given the option of paying tuition, fees, and residence hall charges (in the case of single graduate student housing only) on an installment basis. Tuition and fee charges for each of the first and second semesters are collected in four installments, the first payable at registration and the remaining in each of the following months. The advance deposit, if paid, is applied against the first installment. If this results in overpayment, the remainder is applied against subsequent installments.

Summer session charges are payable one-half at registration and one-half during the following month. This plan does not apply to registration in extramural and correspondence courses. University housing for married students is contracted on an annual lease basis and payments are made by the month.

Students electing the installment plan for payment of tuition and fees are assessed a $2.00 service charge. An additional service charge of $2.00 is assessed in the case of the flight instruction fee of $375.00 if paid on the installment basis. There is no service charge for the payment of University housing accounts on the installment basis. Arrangements for payment on the installment plan are made with the Business Office during registration. An installment is considered delinquent on the first day of the month following the date payment is due. Penalties may be imposed on students who permit their accounts to become delinquent, including cancellation of registration.

Refund of Fees

A student subject to tuition and/or fees who files clearance papers for withdrawal from the University during any semester, quarter or summer session, for reasons other than military or other approved national defense service, receives a refund as listed below. (Special refund regulations govern withdrawals for active military or other approved national defense service.)

IN A SEMESTER:

(1) During the first ten days of instruction in a semester, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $30.00.[1] When the total assessment has been less than $30.00, the full amount of the assessment, if any, is nonrefundable.

(2) After the first ten days but within the first half of the semester, one-half of the total amount of the tuition and fees assessed which remains after deduction of the nonrefundable charge is refunded.

(3) After the midpoint of the semester, no refund is allowed.

IN AN EIGHT-WEEK SUMMER SESSION:

(1) During the first five days of instruction in the summer session, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $20.00.[1] When the total assessment has been less than this amount, the full amount of the assessment, if any, is nonrefundable.

(2) After the first five days but within the first half of the summer session, one-half of the amount assessed which remains after deduction of the above mentioned $20.00 is refunded.
(3) After the midpoint of the summer session, no refund is allowed.

A student who reduces his registration to a lower range receives a refund of the full amount of the difference in tuition and fees specified for such schedules provided the changes are made during the period designated for refund of full fees in case of withdrawal from the University. One-half of the above differences is refunded if the changes are made during the period for one-half refund in case of withdrawal from the University. Thereafter, no rebate is allowed.

FINANCIAL AID

Various types of financial assistance are available each year to promising students in all fields of study in the Graduate College. Detailed information about qualifications and application procedures for these awards is given in the brochure, *Financial Aid for Graduate Students,* which may be obtained by writing to the Graduate College or to any of the graduate departments.

The principal kinds of awards are listed below.

Fellowships

University Fellowships. University Fellowships, which are awarded on the basis of an all-University competition, are generally unrestricted as to the student's field of graduate study and provide stipends of not less than $2,000 for the academic year, or $2,500 for eleven months, with exemption from tuition and all regular fees which are assessed at the time the student registers. A student receiving a University Fellowship may accept, if offered, a part-time teaching assistantship to a maximum of one-quarter time. University Fellows must carry a full program—four units or the equivalent.

Fellowships are also provided for teaching assistants for the summer session only. These awards are restricted to graduate students who have held teaching assistantships at the University of Illinois for at least half-time for both semesters of the preceding academic year, who have earned not less than two units of graduate credit during that year, and who have demonstrated superior scholarship. Like regular Uni-

[1] The nonrefundable charge includes the hospital-medical-surgical insurance fee, if originally paid; the student who withdraws from the University continues to be covered by the insurance until the close of the term.

versity Fellows, they are selected on the basis of an all-University competition. The Summer Fellowships carry stipends of $500, for the eight-week summer session, plus tuition and fee exemptions.

In addition to the all-University awards, there are Fellowships in the Creative and Performing Arts. These awards are made primarily on the basis of the applicant's creative achievements and promise rather than on his academic and scholarly qualifications. Students in the fields of dance, theatre, architectural design, landscape architecture, sculpture, painting and printmaking, graphic design, industrial design, and music are eligible. Applicants may contact the appropriate department.

National Defense Graduate Fellowships. National Defense Graduate Fellowships are financed under Title IV of the National Defense Education Act of 1958, and administered with the cooperation of participating universities. This program assists students who are preparing to teach in the nation's colleges and universities. Each fellowship, restricted to citizens or permanent residents of the United States, is for a three-year period to a student beginning his graduate studies. The stipend for the academic year is $2,000 for the first year, $2,200 for the second, and $2,400 for the third, plus an allowance for dependents. Students who attend the summer session following the academic year may receive $400, plus dependency allotment. These followships provide exemption from tuition and all regular fees which are assessed at the time the student registers. A holder of a Title IV fellowship may, under certain conditions, also be appointed as a part-time teaching assistant.

Under Title VI (Modern Foreign Languages) of the National Defense Education Act, the University of Illinois participates in programs in Asian, Russian, and in Latin-American Language and Area Studies. These fellowships, restricted to citizens or permanent residents of the United States, are intended for students planning a college or university teaching career or other career centering on problems of the language area. The stipend for the fellowships, which is renewable, is $2,250 for the academic year, or $2,700 for the summer and academic year, plus an allowance for dependents. Title VI fellowships also provide for the payment of tuition and fees.

Requests for information and application materials should be directed to the student's prospective department.

Office of Education Fellowships. The Higher Education Act of 1965 provided for support of elementary and secondary teachers through the Experienced and Prospective Teacher Programs. The University now has a program for Experienced Teachers in English and for Prospective Teachers in Mathematics, Music Education, and Education for

the Disadvantaged. It is expected that the program will be expanded to include other fields of study. For information write to your prospective major department.

Industrial, Endowed, Special Fellowships, and Traineeships. Various industrial firms, foundations, government agencies, and private individuals have generously donated funds to support special fellowships for graduate students at the University of Illinois. The stipends and supplemental allowances of these fellowships are not uniform, and most of them are restricted to students in particular areas of study. Brief descriptions of the names, donors, fields, and other conditions pertaining to each are presented in the brochure, *Financial Aid for Graduate Students.*

Traineeships

National Science Foundation Traineeships. Under this program, grants are made directly to the participating institutions, who select promising individuals for full-time graduate study. Appointments may be made only to citizens of the United States (or native residents of a United States possession) who are enrolled in programs leading to an advanced degree in the mathematical, physical, medical, biological, or engineering sciences, anthropology, economics, geography, the history and philosophy of science, linguistics, political science, psychology, and sociology. Also included are interdisciplinary areas which are comprised of overlapping fields among two or more sciences (for example, geochemistry and meteorology).

The basic stipends for twelve months are $2,400 for those at first-year level, $2,600 for those at intermediate-year level, and $2,800 for those at terminal-year level, plus exemption from tuition, service fee, and hospital-medical-surgical insurance fee. An allowance of $500 is granted for each dependent. Recipients of these awards may elect a nine months' tenure, rather than twelve months, with a corresponding decrease in the stipends and allowances. In addition, traineeship awards may be available for the summer session only.

Inquiries concerning traineeships should be directed to the appropriate department at the University.

National Aeronautics and Space Administration Traineeships. The National Aeronautics and Space Administration sponsors traineeships at the University of Illinois for students who are majoring in the space-related sciences and technology. Awards are made to first-year graduate students and provide an annual tax-free stipend of $3,200 for twelve months, with exemption from tuition and all regular fees that

are assessed at the time of registration. Advanced students and students with dependents receive up to $3,400. NASA trainees must carry a full program—four units or the equivalent—and may accept an additional teaching appointment up to one-fourth time. Inquiries concerning this program should be directed to the student's prospective major department.

Public Health Service Traineeships. These appointments are designed to permit graduate students to receive advanced training in certain specialized areas, such as social work, mental health, public health, and vocational rehabilitation. A traineeship is virtually equivalent to a fellowship since the stipend is considered a tax-free gratuity and no duties are required other than those directly contributing to the training program. The stipends vary from $1,800 to $2,800 or more depending on the recipient's level of study and area of specialization. Tuition and fees also are ordinarily covered. Inquiries concerning traineeships should be directed to the student's prospective major department.

Assistantships

The various departments of the University employ graduate students as teaching or research assistants. The usual appointment is for half-time service, at a salary of $2,400 for the academic year (September to June). Applications may be made directly to the appropriate department.

Assistants holding appointments ranging from 25 through 67 per cent of full-time service are exempt from the tuition and service fee, but not from the hospital-medical-surgical insurance fee. For more detailed information concerning fee assessment, see pages 26 to 29.

Appointments for part-time assistantships also are available in non-teaching bureaus and agencies. For further information and application materials, write directly to: Bureau of Business Management, Bureau of Community Planning, Bureau of Economic and Business Research, Center for Instructional Research and Curriculum Evaluation, Department of Computer Science, Institute of Communications Research, Institute of Government and Public Affairs, Institute for Research on Exceptional Children, Physical Environment Unit, and Small Homes Council-Building Research Council. All agencies may be addressed in care of the University of Illinois, Urbana 61801.

Part-time appointments as student residence hall counselors are also available. These provide cash stipends plus room and board and the same exemption from tuition and the service fee accorded other staff members. For further information, students should write to the Dean of Men or the Dean of Women, Student Services Building.

Tuition and Fee Waivers

These awards provide exemption from the tuition and service fee, but not from the hospital-medical-surgical insurance fee, for the academic year and the summer session immediately preceding or following. Students holding these awards must be in residence and must register for at least three units each semester during the academic year. They may, however, accept part-time or incidental employment not to exceed twenty hours a week either within or outside the University.

Veterans who are admissible to a graduate program and who meet certain residence requirements may be eligible for exemption from tuition and certain fees under the state statute concerning Military Scholarships. Further information may be obtained from the Director of the Undergraduate Scholarship Program, 707 South Sixth Street, Champaign, Illinois 61820.

How to Apply

Application materials with instructions may be obtained from the Graduate College or from any graduate department. Only one application form is needed to apply for any of the types of financial aid listed on pages 32 to 36, except the Defense Education Act Title VI Fellowships. The latter application may be obtained from Professor Angelina R. Pietrangeli, Chairman of the Committee on NDFL Fellowships, 223 Lincoln Hall, Urbana, Illinois 61801.

To be considered for a University Fellowship beginning in June or September, the application must be filed with the major department no later than February 15. Applications for tuition and fee waivers and assistantships are accepted after that date, but applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer assistantships at the same time they consider applications for fellowships. An age limit of thirty-five years applies to applicants for University Fellowships and Tuition and Fee Waiver.

Announcement of Awards

Fellowship awards are announced by the Graduate College on or about April 1. Recipients are expected to accept or decline by April 15.

The University of Illinois adheres to the following resolutions adopted by the members of the Association of American Universities and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, or

fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom to reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

Loan Funds

Long-term loan funds are available to those students who have a demonstrated financial need. The amount of loan that is finally approved by the University Committee on Loans is subject to the availability of funds, and no commitment is made until all financial information has been reported.

The signature of a qualified endorser or satisfactory collateral is required for all long-term loans. Exceptions to this requirement may be made by terms of the loan fund or may be waived in meritorious cases by the Director of Student Financial Aids and the Bursar's Office. Each application must be signed by the applicant's department chairman.

Students must be in good standing before an application is accepted for processing. If loans are made over a two-semester period, the student must remain in good standing to receive a second advance. Any exceptions to this rule must be requested from the Student Loan Office.

Illinois State Guaranteed Loans. The Illinois General Assembly has authorized an Illinois loan program to guarantee student loans made by commercial lenders to legal residents of the state of Illinois. An eligible student may borrow from a minimum of $300 to a maximum of $1,500 for a first-year graduate or professional student, $1,500 for a second-year graduate or professional student, etc. It is planned that a student will borrow only once during the academic year. Repayment does not begin until the student either graduates or ceases full-time study.

No loan will be granted in an amount which exceeds the established educational expenses at the eligible college selected by the student, minus other scholarship or loan assistance.

Applications may be secured from the Bursar's Office, 100b Administration Building, and the Student Loan Office, 346 Student Services Building.

ACADEMIC AND OTHER REGULATIONS

A student should familiarize himself with the academic requirements and regulations of the Graduate College and of the department in

which he is working. He is responsible for complying with these regulations and for fulfilling all requirements for his particular degree. Every graduate student should have a Graduate College catalog and, if available, a departmental brochure. The Graduate College calendar included in this catalog is also printed separately and may be obtained from the Graduate College Office, 330 Administration Building.

Petitions

The normal procedures and requirements of the Graduate College are indicated in this catalog. A student may petition to the Dean of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms for such petitions may be secured at the Graduate College Office.

Residence

Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable portion of his time to graduate studies. A student who is regularly employed outside the Urbana-Champaign community is not considered to be in residence even though he is registered in a campus course.

Work Completed Elsewhere

A candidate for the doctorate, who has received a master's degree from a recognized institution, receives the equivalent of eight units of credit for that work. If such credit is to be used in partial fulfillment of the requirements for the doctorate, he is examined on the content of the courses involved at the time of the preliminary examination.

A student who has completed graduate work in a recognized institution, but without receiving a degree, may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for an advanced degree.

Time Limit for Advanced Degrees

A candidate for the master's degree must complete all requirements for the degree within five calendar years after his first registration in the Graduate College.

A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in the following paragraph.

A candidate for the doctorate, who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. A student whose program of study is significantly interrupted after he receives a master's degree from the University of Illinois and who later returns to work for his doctorate will have five years from the date he returns to complete degree requirements.

Advisers

Every graduate student must have an adviser in the department or school in which he is a degree candidate. The adviser's primary duty is to assist in planning a program of graduate work which fits the needs of the student and satisfies departmental and Graduate College requirements. A new student should go to his major department to discuss the selection of an adviser.

Unit Credit for Courses

Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester; the maximum permissible is five. The normal program for an eight-week summer term is two units; the maximum permissible is two and one-half units.

Grades

Grades are recorded by letters as follows: for thesis research and non-credit seminars, S and U (satisfactory and unsatisfactory); for courses, A, B, C, D, and E (failure). A student who receives as much as two but *less* than three units of grades below B must replace such units with additional units of A or B grade to qualify for an advanced degree. Three units of grade below B disqualify a student as a degree candidate.

Maximum and Minimum Registration

Students holding University Fellowships or other fellowships awarded by the University must carry a full program (four units or the equivalent). Those awarded tuition and fee waivers must carry a minimum program of three units or the equivalent. The academic work carried by assistants and others on the University staff is limited

by statute, and those employed outside the University are expected to reduce their programs of study in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Terms of Employment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1¼ units
Two-thirds time	2¼ units	1½ units
One-half time	3 units	1¾ units
One-third time	3¾ units	2 units
One-fourth time	4 units	2 units

Exceptions to the *semester* schedule are possible by means of a special petition procedure. This privilege does not apply to summer session.

Conferring of Degrees

Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August. No more than two graduate degrees will be conferred for work completed at the University of Illinois.

THE MASTER'S DEGREE

Master's degrees are offered in the fields indicated on pages 8 and 9. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units. Three of the eight units must be in courses numbered in the 400 series, and two of these three must be in the major field.

Residence

A candidate must spend at least two semesters, or the equivalent, in residence and must earn at least half the required units while in residence.

Major Requirement

At least four units of work must be in the area of concentration. The remaining credit may be in that field or in other courses appropriate to the student's educational goals.

Thesis

A student electing or required to write a master's thesis should file the subject of the thesis at the Graduate College Office at least six weeks prior to graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research can not be applied to a degree unless a thesis is submitted.

For specific instructions regarding the format of the thesis, the student should obtain a copy of the leaflet, *Instructions for Preparation of Theses,* from the Graduate College Office.

Master's Degrees in Teacher Education

Programs leading to master's degrees for teachers are available in the areas listed below. Students are eligible if (1) they have completed all the requirements of a four-year undergraduate curriculum for teachers, and if (2) they are otherwise eligible for admission to graduate study in the departments administering these programs.

Agricultural Education—page 60
Art—page 79
Biological Sciences and General Science—page 232
Chemistry—page 96
Earth Science—page 191
English—page 168
English as a Second Language—page 168
French—page 182
Geography—page 187
German—page 195
Health Education—page 197
Home Economics—page 207
Latin—page 117
Mathematics—page 264
Music—page 286
Physical Education—page 303
Physical Sciences—page 306
Physics—page 305
Russian—page 335
Social Studies—page 339
Spanish—page 351
Speech—page 356
Speech Correction—page 356

In addition to the curricula listed above, any programs leading to the master's degree in education with emphasis in a number of teaching fields are described on page 138.

Programs Leading to the Master's Degree and Teacher Certification

The above programs also are available to students who have not met all the requirements of a four-year undergraduate curriculum for teachers, but who wish to take the fifth year of work for a master's degree. The transcript of the applicant is evaluated for the purpose of determining the courses necessary to fulfill teacher certification requirements as well as master's degree requirements. The admission of such students to graduate study in departments other than Education requires the approval of the appropriate adviser and of the Coordinator of Teacher Education.

Those who have not completed student teaching must do so in order to be eligible for the teacher education master's degree. The usual criteria for admission to student teaching are applicable. For more detailed information, see "Council on Teacher Education, Student Teaching," in the Undergraduate Study catalog. Normally, the student admissible to graduate study will have met the grade-point average required for admission to student teaching. However, at least one semester of study at the Urbana campus must have been completed with satisfactory grade-point average before a student may be admitted to student teaching. The candidate must register concurrently in technic of teaching (the methods course) and educational practice (student teaching) for undergraduate credit.

Students who have not previously completed an undergraduate course in educational psychology may take a proficiency examination in Educational Psychology 211. A successful proficiency examination or passing grade in educational psychology is required for admission to Educational Psychology 311 and 312.

Normally, professional education requirements for certification will have been fulfilled by a program which includes the following courses:

Educational Psychology 211 (or equivalent) ..... 3 semester hours
Elementary Education 231 or Secondary Education 241 .... 3-5 semester hours
Educational Practice 232 or 242 ..... 5 semester hours
History and Philosophy of Education 304 ..... ½ unit
History and Philosophy of Education 305 ..... ½ unit
Educational Psychology 311 ..... ½ unit
Educational Psychology 312 ..... ½ unit

It should be noted that only 300- and 400-level courses may apply toward the master's degree.

The student must also meet the general education and teaching field requirements prescribed in the appropriate undergraduate curricula for teachers. Students pursuing both certification and master's gree requirements, as described above, should anticipate at least the equivalent of three semesters of full-time study.

THE DEGREE OF THE DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered in the fields indicated on pages 8 and 9. The general requirements for this degree are described below and any special requirements are given in the departmental listings. For information concerning professional degrees at the doctoral level in business administration, education, law, and music, see the appropriate departmental sections.

Residence

A doctoral program includes three stages of progress, as defined below. At least two of these stages must be completed in residence and this period in residence must include two successive semesters in the second or the third stage.

The first stage is completed when the candidate has received a master's degree or has earned the equivalent number of credits (eight units or thirty-two semester hours); *the second stage* consists of eight units of work, fulfillment of the major and minor course requirements, the language requirements (if not completed earlier), and a successful preliminary examination; *the third stage* is devoted to research and seminars (eight units), the preparation of the dissertation, and the final examination.

It is possible to complete these three stages in three years if the student devotes full time to his academic program. For information concerning the maximum time allowed, see page 38.

Programs of Study and Areas of Specialization

Each student's schedule of course work and research is planned in consultation with his adviser, with consideration given to the candidate's previous academic training, his career objective, the general regulations of the Graduate College, and any specific departmental requirements. It is the student's responsibility to be aware of these regulations and requirements, and to satisfy them as early as possible.

The major area of specialization consists of a selection of courses closely related to each other, not all of which are necessarily offered by the major department.

If a student elects or is required by departmental regulation to declare a minor outside his major department, the selection of courses must be approved by the department or division concerned. A minor area of specialization consists of a group of course offerings that have a distinct relationship though they may be offered in more than one department.

Language Requirements

A candidate for the degree of Doctor of Philosophy must demonstrate a reading proficiency in two languages other than English, or a high degree of proficiency in one language other than English. Although French, German, and Russian are acceptable in all doctoral programs, candidates in some departments may be permitted to sub-

stitute other languages. See departmental listings for specific requirements and for exceptions to the general regulations that are described here.

A candidate should qualify in at least one of the required foreign languages during the first year of study. The entire language requirement should be satisfied early in the doctoral program, and in any event no later than two months before the preliminary examination, or during the term (or summer session) preceding admission to the preliminary examination.

Students may satisfy reading proficiency by (1) a direct examination administered by the language department; (2) receiving an acceptable score on the Educational Testing Service Test in the language; or (3) obtaining grades of A or B in French, German, or Russian 401.

To satisfy the language requirement by exhibiting a high proficiency in one language, a student must pass a written reading proficiency examination and must (1) show ability to discuss his research and to answer questions in the language; (2) understand and give a resumé of what the examiner reads to him from material in his field; (3) carry on a conversation on the subject of his background and plans.

Certification of proficiency in foreign languages from other colleges and universities is not accepted by transfer, but scores on the ETS Language Tests taken elsewhere will be accepted and evaluated.

Preliminary Examination

To enter the third stage of a doctoral program (see page 43), a candidate must pass a preliminary examination to test his qualifications for further advanced study and research. The examination may be written, oral, or both, according to departmental requirements. The candidate is certified for admission to the third stage by a committee appointed by the Dean of the Graduate College on the recommendation of the Executive Officer of the major department.

Thesis

The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination. After passing this examination, the candidate *must* register each term (summer sessions excluded) until he receives his degree. When the credit requirement is satisfied—eight units of thesis

research subsequent to passing the preliminary examination—the student maintains his status as a candidate by registering for zero credit in Thesis Research (499).

Candidates engaged in thesis research may find it desirable or expedient to publish prior to the conferral of the degree, certain findings that later will be incorporated in the dissertation. In this case appropriate acknowledgement of the earlier publication should be included in the dissertation. The Graduate College encourages such publication, but the thesis in its entirety may not be published before all degree requirements have been completed.

Directions regarding the format of the thesis are given in the leaflet, *Instructions for Preparation of Theses,* which may be obtained in the Graduate College Office. The candidate must submit to the Graduate College, no later than the date specified in the current calendar, (1) the original and first carbon copy (or two copies reproduced by an approved method) of his thesis, and (2) one typewritten copy of an abstract not exceeding six hundred words.

Each candidate who passes the final examination must pay a $25.00 microfilm fee. This provides for (1) microfilming the complete thesis, with one copy deposited in the University of Illinois Library, and (2) publication of the abstract in *Dissertation Abstracts.*

Final Examination

After the credit requirements for the third stage have been satisfied, and the thesis completed, the candidate is admitted to the final examination upon recommendation of the major department.

SPECIAL EDUCATIONAL OPPORTUNITIES

Traveling Scholar Program

The University of Illinois is one of eleven midwestern member universities of the Committee on Institutional Cooperation and a participant in the Committee's Traveling Scholar Program. This program enables an advanced graduate student to work at another campus for a semester in order to take advantage of special course offerings or research facilities, such as a unique laboratory or library collection, not available at his own institution. A CIC Traveling Scholar registers at his home university, and credit for the work is recorded there. Appointment as a Traveling Scholar is based upon the individual submission to the Graduate College of an application which carries the

strong endorsement of the student's major department and the approval of the host institution. Each university retains the right to accept or reject any student desiring to study under its auspices. A student interested in participating in the program should consult with the head of his major department.

Auditing Privileges

A graduate student or a person not registered in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a form bearing the approval of the instructor and the Dean of the Graduate College is filed with the Records Office, 69 Administration Building. A student should not enter on his program card any courses which he plans to attend as an auditor.

Extramural Courses

Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor more than one unit in any combination of extramural and campus courses.

Because extramural course work is not considered work in residence, credit earned in such courses can be applied toward an advanced degree only if (1) the courses are approved in advance by the adviser and constitute part of a well integrated program, and if (2) the total extramural credit does not exceed two units (the Ed.M. and the Advanced Certificate excepted). Credit earned in extramural courses can not be applied toward the second stage of a doctoral program (see page 43).

Correspondence Courses

Credit earned in correspondence courses can not be applied toward an advanced degree. However, it is possible to fulfill certain prerequisites or remove deficiencies through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 104 Illini Hall.

Fields of Instruction

Courses open to graduate students are of two types. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only. Those numbered 500 to 599 are open only to graduate students in certain professional programs.

All courses for graduate students require previous preparation. By consultation with the instructor, a student may determine whether he has had the necessary prerequisites for a particular course.

Courses in this catalog are listed alphabetically by departments. The offerings in each field are arranged numerically in groups, with headings to indicate the students for whom they are designed. The 400 series are listed first; courses in the 300 series follow. After the title of each course is a brief description of its contents, the credit given, and the requirements for admission to the course.

A number of courses offer variable credit. At the 300 level, additional work in the nature of special reports, papers, or projects is required of a student who registers for the maximum credit shown. In each case, the student, with help of his adviser, determines whether or not his schedule allows sufficient time to complete the work required for maximum credit.

At the 400 level, research, reading, and independent study courses provide variable credit; proportionate time devoted to a particular activity can thus be indicated on the student's record.

Unless otherwise specified, it can be assumed that a course is offered at least once during each calendar year. Courses offered only in the summer session are indicated by "S"; courses given in alternate years are indicated with the year of offering. A complete listing of courses for each term is contained in the Time Table, published about six weeks prior to the beginning of each term and available from the Graduate College, 330 Administration Building.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the Master of Science and Doctor of Philosophy in Accountancy and to the Master of Accounting Science.

The grade-point average required for admission to graduate study in accountancy is 4.0. Applications from students with a grade-point average between 3.75 and 4.0 are considered on an individual basis. All applicants, native or foreign, are required to take the Admission Test for Graduate Study in Business. This test should be taken early enough to insure that the results will be available to the department prior to action on admission. All applicants except those applying for the Master of Accounting Science (M.A.S.) program for non-business graduates should have the equivalent of the undergraduate curriculum at the University of Illinois, including twenty hours of undergraduate work in accountancy (twenty-four hours for M.A.S. candidates), courses in economic theory and the functional areas of business, two courses in statistics, courses in finite mathematics and calculus, and a course in or knowledge of computer programming and applications. In addition, applicants must take or have credit (graduate or undergraduate) in linear algebra and operations research. Opportunities are provided to remove any entrance requirements early in the student's program.

For all graduate programs in the Department of Accountancy, two courses are required: Accountancy 481, Concepts and Principles, and Accountancy 483, Income Determination. Candidates for the Master of Accounting Science program are also required to take Accountancy 594, Methods and Practices in Professional Research.

Master of Science. Eight units of graduate work, of which at least six must be at the 400 level, are required for the Master of Science degree. A candidate must have at least five units in accountancy, two of which are earned by the satisfactory completion of a master's thesis. The remaining three units may be taken in accountancy or in other fields, including one or more minors, subject to the approval of the graduate adviser.

Master of Accounting Science (professional degree). This program is designed for candidates who wish to prepare for professional careers in public, governmental, or industrial accounting. For graduates of business schools with credit in appropriate undergraduate courses, the M.A.S. degree requirements can be completed in one year. For non-business graduates, the M.A.S. can be earned in two years.

Candidates qualifying for the one-year M.A.S. degree must complete eight units of graduate credit. Four of the eight units are required to be taken in accountancy courses. No thesis is required. In addition to Accountancy 481, 483, and 594, one graduate level course in both economic theory and in organizational theory are required. A graduate adviser assists each student in complying with the program requirements as well as the selection of electives.

For non-business students, the department offers a two-year M.A.S. program. During the first year, the student normally takes Accountancy 501, 502, 503, and 504. Depending upon his background, he also enrolls in courses in statistics, business economics, operations research, business organization, and decision theory. In his second year, he satisfies the requirements of the one-year M.A.S. program outlined above. Adequate provisions have been made for electives suited to the particular interests of the student subject to the approval of his adviser.

Students who believe they already meet some of the requirements of the two-year M.A.S. program are given the opportunity to substitute elective courses for areas in which they can satisfactorily demonstrate their proficiency. In all, sixteen units of graduate work are required to complete the two-year program.

Doctor of Philosophy. A candidate for the Doctor of Philosophy degree is required to satisfy the prerequisites for graduate study in accountancy, stated above, and have his admission approved by the departmental admissions committee which may require an oral or written examination.

The requirements for the Doctor of Philosophy degree include a master's degree,

credit in micro- and macro-economics, a minor or minors of at least four units in fields other than accountancy, at least eight units in accountancy (including not less than six units taken for graduate credit at the University of Illinois), and additional units to bring the total to at least twenty-four, including those taken for a master's degree. Eight of the twenty-four must be doctoral dissertation units. The doctoral program of each student, including the selection of an appropriate minor or minors, is subject to the approval of the graduate adviser.

The candidate is required to pass examinations in two foreign languages, an oral and written preliminary examination prior to dissertation research, and an oral final examination on his doctoral dissertation. In his preliminary examination the candidate must demonstrate a thorough knowledge of accounting theory and of the areas of accountancy in which he specialized, a general acquaintance with the subject matter and bibliography of other areas of accountancy, and proficiency in his minor fields.

Requests for further information about any of the programs described above should be addressed to the head of the department, 360 Commerce and Business Administration Building (West).

GRADUATE FACULTY

Professors: E. J. DeMaris (Head of Department), N. M. Bedford, R. I. Dickey, C. F. Dunham, H. P. Holzer, Dorothy Litherland, G. E. Lukas, R. K. Mautz, C. A. Moyer, K. W. Perry, D. H. Skadden, W. E. Thomas, N. D. Wakefield, V. K. Zimmerman.

Associate Professors: G. D. Brighton, P. E. Fess, H. M. Schonfeld.

Assistant Professors: D. J. Casler, J. W. Deskins, M. Uretsky, C. Weber.

PROFESSIONAL COURSES

501. Accounting Analysis, I. Uses of accounting information; collection, processing, and communication of accounting information; measurement of assets, liabilities, equities, and income; accounting system design. ¾ unit.

502. Accounting Analysis, II. An in-depth study of accounting valuation processes and accounting income measurement; special reporting problems of multiple-entity organizations; accounting for non-profit organizations. ¾ unit. Prerequisite: Accountancy 501 or equivalent.

503. Managerial Accounting. Introduction to management accounting as a part of a firm's information system, in terms of modern cost accounting and budgetary systems for planning and controlling business operations. 1 unit. Prerequisite: Credit or registration in Accountancy 501 or equivalent.

504. Taxation and Auditing. Introduction to historical and conceptual material in specialized accounting areas of taxation and auditing. Emphasis centered on provisions of the tax law relevant to accounting measurement methods and on nature of evidence in auditing, auditing standards and techniques, and ethical constraints imposed on the auditor. 1 unit. Prerequisite: Accountancy 501, 503, or equivalent.

566. Accounting Problems of Industrial Management. A development of the role and importance of cost and revenue data in the process of enterprise administration. Attention is focused on the goals of the firm and the possible aid in achieving these goals that would come from properly conceived, prepared, and utilized cost and revenue data. For Master of Accounting Science and Master of Business Administration students only. 1 unit. Schonfeld.

577. Professional Problems. Instruction as to types and methods of solution of professional problems in public accounting, including practice in analyzing and solv-

ing a wide variety of such problems. For Master of Accounting Science students only. 1 unit. SKADDEN, WAKEFIELD.

594. **Methods and Practices in Professional Research.** Instruction in research methods, materials, and techniques together with individual practice in conducting and reporting on specific professional research projects. For Master of Accounting Science students only. 1 unit. DESKINS, ZIMMERMAN.

COURSES FOR GRADUATES

432. **Accounting Under Different Social Systems.** An inquiry into the ways accounting has been adapted to the needs of different social systems; the extent of its contribution; its apparent limitations. Consideration is also given to the relationship between accounting and the growth and development of social systems. 1 unit. Prerequisite: Consent of instructor. DEMARIS.

441. **State and Federal Accounting Theory.** Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. 1 unit. LUKAS.

455. **Macro-Accounting.** Same as Economics 425. An examination of the fundamental concepts underlying the attempts to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor. ZIMMERMAN.

461. **Administrative Accounting.** Accounting as a tool for management; organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. 1 unit. HOLZER, THOMAS.

466. **Cost Accounting Theory and Analysis.** A critical examination of cost accounting methods as to truth and expediency. 1 unit. DICKEY, HOLZER.

471. **Accounting Reports.** Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. 1 unit. WAKEFIELD.

472. **Auditing Standards and Techniques.** A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. 1 unit. MAUTZ, MOYER.

473. **The Theory of Accounting System Design.** Problems and procedures in connection with designing and installing accounting systems. 1 unit. THOMAS.

474. **Income Tax Development.** A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. 1 unit. BRIGHTON, SKADDEN.

475. **Accounting Information System Simulation.** An examination of the concepts and methodology of simulation, with particular emphasis on the information system of the firm. A simulation model is developed and used as a basis for deriving information regarding system performance. 1 unit. Prerequisite: Mathematics through calculus, knowledge of computer programming, or permission of instructor.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. 1 unit. Bedford, Mautz, Moyer.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. 1 unit. Bedford, Fess, Mautz.

484. **The Accounting Theory of Business Income.** An examination of the development and essential characteristics of the accounting theory of business income evaluated in the light of criticisms implicit in other concepts of income; the social significance of business income theory. 1 unit. Mautz.

485. **Relationship of Accounting Theory to Philosophy, Science, and Other Disciplines.** An examination of the relationship of accounting theory to the developments, thoughts, and methods in the fundamental intellectual disciplines. 1 unit. Bedford.

487. **Surplus and Dividends.** The theories underlying the treatment of balance sheet items deserve close consideration in accounting, because the balance sheet reflects the effect of conflicting ideas about the bases for setting up restrictions on the freedom of directors to dispose of corporation assets as dividends. 1 unit. Perry.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. 1 unit. Zimmerman.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. ¼ to 2 units. Staff.

499. **Thesis Research.** Individual direction and guidance in writing theses, and seminar discussions of progress made. 0 to 4 units. Dickey.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. ¾ unit. Prerequisite: Accountancy 106 or 166, and 108; an average of C or better in preceding courses in accountancy. Bedford, Deskins, Fess, Wakefield.

325. **Accounting System Design.** An introduction to the fundamentals of accounting system design. This includes the design and use of business papers, records, and reports; the functions of business machines in accounting systems; and personnel problems in accounting system design. ¾ unit. Prerequisite: Accountancy 308. Weber.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. ½ unit. Prerequisite: Accountancy 108. Brighton, Lukas.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. ¾ unit. Prerequisite: Accountancy 108. Holzer, Schonfeld, Thomas.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. Dickey, Holzer, Schonfeld.

371. **Auditing.** Nature of audit evidence, basic audit techniques, audit practices and procedures, professional ethics, audit reports. ¾ unit. Prerequisite: Accountancy 308. Fess, Mautz, Wakefield.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. ¾ unit. Prerequisite: Accountancy 371. Fess, Moyer, Zimmerman.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. ¾ unit. Prerequisite: Accountancy 274 and 308. Brighton, Skadden.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. 1 unit. Prerequisite: Credit or registration in Accountancy 371. Dunham, Lukas.

378. **Advanced Theory and Practice.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory auditing, ethics. 1 unit. Prerequisite: Accountancy 377. Wakefield.

ADVERTISING

The Department of Advertising offers graduate work leading to the Master of Science in Advertising. For the program leading to the Doctor of Philosophy in Communications, see page 118.

Admission to graduate study in advertising requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in advertising or a related field, English, commerce, or the other social sciences, and (2) a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science. Requirements for this degree include:

(1) A minimum of eight units (with thesis) or nine units (without thesis).

(2) Four units of advertising, or three units and one additional unit approved by the adviser. Candidates must select at least three units from Advertising 481, 482, 483, or 484. Advertising 382, 383, 384, and 387 also must be included unless these courses, or the equivalent, were previously taken.

(3) A minimum of two units of non-advertising courses.

(4) A thesis of one or two units; or in lieu of a thesis a minimum of nine units of course work (including no less than one-half unit of Advertising 490).

(5) A minimum of four units of credit at the 400 level.

GRADUATE FACULTY

Professors: S. W. Dunn (Head of Department), C. H. Sandage, N. Wedding.

Associate Professors: A. M. Barban, J. E. Moyer, H. W. Sargent.

COURSES FOR GRADUATES

481. **Advanced Advertising Principles.** Same as Communications 481. Emphasis is placed on determination and understanding of the principles as related to the sci-

ence, philosophy, and art of advertising. Students may not receive graduate credit for both Advertising 481 and 388. 1 unit. SANDAGE.

482. **Research Methods in Advertising and Communications.** Same as Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. DUNN.

483. **Advertising and the Mass Media.** Same as Communications 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit. MOYER.

484. **Advertising and Consumer Behavior.** An examination of consumer behavior as a means of shaping the communications message; use of the behavioral sciences in creative communication strategy. 1 unit. BARBAN.

490. **Special Topics in Advertising.** ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

499. **Thesis Research.** 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. ½ unit. MOYER.

382. **Advertising Copy and Layout.** Theory and practice of advertising; message creation and arrangement for print and broadcast media; advertising planning for the local advertiser; use of consumer and market surveys, copy-testing methods, and advertising readership studies. ½ unit. Prerequisite: Advertising 281. SARGENT.

383. **Advertising Media.** Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. ½ unit. Prerequisite: Advertising 281. BARBAN.

384. **Advertising Campaigns.** Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements—copy and layout. ½ unit. Prerequisite: Advertising 382 and 383, or consent of instructor. MOYER.

385. **Advertising Promotion and Sales.** Sales problems, advertising promotion, advertising research, market research. ½ unit. Prerequisite: Advertising 281.

386. **Radio and Television Advertising.** Economics, standards, and ethics as applied to radio and television commercials; sponsorship, rates, and advertising techniques; preparation and presentation of radio and television advertising copy, measurements, and listener surveys. ½ unit. Prerequisite: Advertising 281.

387. **Advertising Policies and Problems.** Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. ½ unit. Prerequisite: Advertising 281. WEDDING.

388. **Advertising in Contemporary Society.** A study of advertising as an institution and its role in communications, society, our economy, and business. Students may not receive graduate credit for both Advertising 388 and 481. ½ unit. Prerequisite: Advertising 281. SARGENT.

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautical and Astronautical Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy. Study and research are planned to prepare graduates for fundamental and applied work in airplane, missile, and space flight engineering. Typical areas of concentration are aerodynamics, aeroelasticity, astrodynamics, propulsion, structural mechanics, and guidance and control.

The minimum grade-point average for admission to graduate study in aeronautical and astronautical engineering is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The prerequisite for graduate study in aeronautical and astronautical engineering normally is the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical and astronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical and astronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Each student plans his study program in consultation with a departmental adviser. Courses offered by departments other than aeronautical and astronautical engineering may be included in the major area of study when these courses are of particular value to the work which students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical and astronautical engineering must have taken mathematics through the first course in differential equations and the undergraduate aeronautical and astronautical engineering courses, or their equivalents, which are prerequisites to study in the area of the minor work. Deviation from these requirements requires approval from the head of the department.

For information concerning applied mathematics, see page 273.

GRADUATE FACULTY

Professors: H. S. Stillwell (Head of Department), B. L. Hicks, H. H. Hilton, H. W. Knoebel, Y. K. M. Lin, R. W. McCloy, A. I. Ormsbee, R. A. Strehlow, S. M. Yen.

Associate Professors: H. O. Barthel, C. E. Bond, A. R. Zak.

COURSES FOR GRADUATES

411. Advanced Aerodynamics of Compressible Fluids. Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. 1 unit. Ormsbee.

414. Boundary Layer Theory. Theories of the boundary layer of a compressible fluid and their solutions, laminar and turbulent; boundary layer in hypersonic flow. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 and 232, or equivalent. Yen.

415. Wing Theory. Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. 1 unit. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

416. Hypersonic Aerodynamics. Discussion of high Mach number flows including the aerodynamic effects of dissociation and ionization. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 411. Ormsbee.

418. **Theory of Rarefied Gas Flows.** Application of kinetic theory to rarefied gas flow problems; free-molecule flow; near free-molecule flow; linearized problems; flows with appreciable deviation from equilibrium. 1 unit. Prerequisite: Physics 362. YEN.

426. **Theory of Continuous Media.** Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. 1 unit. Prerequisite: Consent of instructor. HILTON.

427. **Thermal Stresses and Creep Buckling.** Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; minimum weight and probability of failure; applications to high-speed airplane, missile, and space vehicle structures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or consent of instructor. HILTON, ZAK.

428. **Theory of Large Deformations in Nonlinear Continuous Media.** Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications: generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, constituent relations for inelasticity. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or equivalent. HILTON.

429. **Theory of Linear and Nonlinear Viscoelasticity.** Fundamental concepts of viscoelasticity with applications. Elastic-viscoelastic analogies, creep and relaxation functions, thermo-mechanical reciprocity relations, variational principles, model fitting, shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, torsion of nonlinear bars and shells. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 426 or consent of instructor. HILTON.

434. **Aerodynamic Heating.** Theory of convective aerodynamic heating in high-speed flow, laminar and turbulent flows; ablation, transpiration cooling, and mass transfer cooling; aerodynamic heating in hypersonic flow, real gas effects, effect of pressure interactions and vorticity interactions; heat transfer in rarefied gas flows. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 and 232, or equivalent. YEN.

438. **Fundamentals of Combustion.** Same as Mechanical Engineering 403. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 or Mechanical Engineering 305. STREHLOW.

451. **Aeroelasticity and Aeroinelasticity.** Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of

elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250 or consent of instructor. ZAK.

452. **Stochastic Structural Dynamics.** Linear structural dynamics problems treated from a probabilistic point of view; axiomatic probability theory and random processes; the response of linear structures to random excitation; practical problems in acronautical and astronautical engineering. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250, Theoretical and Applied Mechanics 412, or equivalent. LIN.

453. **Stochastic Processes in Engineering.** Same as Electrical Engineering 438. This course supplements Aeronautical and Astronautical Engineering 452 or Electrical Engineering 434 for additional engineering applications of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or equivalent. LIN.

490. **Seminar.** Presentation by graduate students and staff of current topics in the fields of aeronautics. No credit. Prerequisite: Graduate standing in aeronautical and astronautical engineering. STREHLOW.

493. **Special Problems.** Theoretical and experimental investigations of problems in airplane, missile, and space flight engineering. 1 to 2 units. STAFF.

499. **Thesis Research.** Research in the various areas of the aeronautical and astronautical sciences. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Foundations of Mechanics and Gravitational Theory.** Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE, STILLWELL.

317. **Elements of Magnetohydrodynamics.** Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, mangetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and crossed-field flows, theory of characteristics, MHD acceleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 or consent of instructor. BOND.

334. **Rocket Propulsion and Rocketry.** The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. ½ unit. Prerequisite: First course in thermodynamics or consent of instructor. MCCLOY.

391. **Special Problems.** Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. ½ or 1 unit. Prerequisite: Consent of instructor. STAFF.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the Master of Science and Doctor of Philosophy. Fields of specialization include farm man-

agement, land economics, agricultural prices and marketing, agricultural finance, agricultural policy, international comparative agriculture, consumption economics, agricultural law, and rural sociology.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the Bachelor of Science in Agriculture at the University of Illinois, including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least eight hours in accountancy, business law, finance, history, management, marketing, political science, or sociology.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The grade-point average required for admission to graduate study in agricultural economics is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

A candidate for the Master of Science degree is required to register for at least two units of economics, including one unit of economic theory. For the Doctor of Philosophy degree, a candidate must complete: (1) a minimum of five units in the social sciences other than agricultural economics, including three units in economic theory of which two must be selected from Economics 400, 401, 402, and 403, and the third from any 400-level course in economic theory offered by the Department of Economics; (2) at least one unit in each of three areas of agricultural economics: production and resource organization, agricultural economic policy, prices and markets (Agricultural Economics 404, 405, and 436); and (3) two and one-half units in analysis and measurement, including at least one-half unit of operations research (Economics 374), one unit of mathematics, and one unit of inferential statistics (Agricultural Economics 441). Equivalent courses completed at another institution will be accepted in fulfillment of these requirements, subject to Graduate College regulations.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics is considered a first minor, in which case the program in that minor requires the approval of the Department of Economics.

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economics and agricultural subjects.

GRADUATE FACULTY

Professors: H. G. Halcrow (Head of Department), C. B. Baker, R. W. Bartlett, G. K. Brinegar, E. E. Broadbent, W. D. Buddemeier, F. Dovring, C. L. Folse, H. W. Hannah, T. A. Hieronymus, J. M. Holcomb, G. G. Judge, R. A. Kelly, N. G. P. Krausz, R. J. Mutti, F. J. Reiss, R. G. Spitze, E. R. Swanson, W. N. Thompson, R. N. Van Arsdall, V. I. West, J. E. Wills.

Associate Professors: J. H. Herbst, M. B. Kirtley, S. C. Schmidt, H. J. Schweitzer, D. G. Smith.

Assistant Professor: L. P. Fettig.

Agricultural Economics

COURSES FOR GRADUATES

401. International Comparative Agriculture. Agricultural and food problems of the world and of selected countries viewed in the world setting; resources and institutional factors affecting production; national and international policies and plans for developing agricultural production and improving levels of living. Emphasis is given to a comparative approach to agricultural development of countries on different economic levels. 1 unit. Dovring.

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. 1 unit. Prerequisite: Economics 300 or an equivalent course in economic theory and one course in statistics. SWANSON.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. 1 unit. Prerequisite: One semester of graduate work or consent of instructor. HALCROW, SCHMIDT.

406. **Research Methodology in Agricultural Economics.** Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. 1 unit. Prerequisite: Economics 400 or 401, or a course of comparable level in the basic field related to the student's research. BAKER.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. Field trip; estimated expense, $8.00. 1 unit. WILLS.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of government agencies; cooperative efforts. 1 unit. BRINEGAR.

441. **Agricultural Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. 1 unit. Prerequisite: An elementary course in statistics. WEST.

442. **Quantitative Analysis in Agricultural Economics.** Application of techniques of quantitative analysis in agricultural economics; construction, estimation, and interpretation of sector, spatial, and input-output models for the agricultural economy. 1 unit. Prerequisite: Agricultural Economics 441, Economics 401, Mathematics 358, or equivalents. JUDGE.

470. **Seminar in Family and Consumption Economics.** Same as Home Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in statistics; Agricultural Economics 370 or consent of instructor. DUNSING.

491. **Seminar and Special Topics.** Each graduate student majoring in agricultural economics must register for this course. Only students who register for credit and complete special studies under the direction of one or more staff members receive credit. 0 to 2 units.

499. **Thesis Research.** Individual research under supervision of members of the graduate teaching staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Financing Agriculture.** Capital and credit needs of farmers; agencies supplying credit; problems of borrowers and lenders. ¾ or 1 unit. Prerequisite: Economics 102 or 103, or 108. BAKER.

303. **Agricultural Law.** Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. ½ to 1 unit. HANNAH, KRAUSZ.

305. **Agricultural Policies and Programs.** The problems of agriculture as an industry and an analysis of past and current federal and state governmental policies and

programs affecting agriculture; objectives and development of policies; the use of economic concepts in evaluating possible future agricultural policies and programs; and forces in policy formation. Field trip; expense, $7.00. ¾ or 1 unit. Prerequisite: Economics 108. SPITZE.

312. **Farm Appraisals.** Same as Agronomy 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. REISS, STAFF.

318. **Land Economics.** Physical, economic, and institutional factors that affect the role of land in economic life; population and resource requirements; principles of land utilization; returns from land; land value; property rights and tenure rights; social controls; rural and urban land development. ¾ or 1 unit. Prerequisite: Consent of instructor. DOVRING.

324. **Farm Operation.** Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. VAN ARSDALL, WILLS.

325. **Advanced Farm Management.** The functions of management; effects of goals and values on management decisions; use of economic analysis in farm production planning including resource allocation and valuation, and cost minimization. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. SCOTT.

326. **Professional Farm Management.** Principles of farm management applied to the problems of those managing farms for others as a profession; development of the profession; relationships with clients and farm operators; division of inputs and returns between owner and operator; direct operation of farms with hired labor; case problems; business practices and procedures; professional ethics. Field trips to farms and professional farm management offices; estimated expense, $15.00. ¾ or 1 unit. Prerequisite: Credit or registration in Agricultural Economics 324; Agricultural Economics 325. HOLCOMB.

331. **Grain Marketing.** Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially future markets; inventory management, operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or an elementary marketing course. HIERONYMUS.

332. **Livestock Marketing.** Same as Animal Science 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

334. **Marketing of Dairy Products.** Same as Dairy Science 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230, an elementary marketing course, or twelve hours of dairy science or dairy technology. BARTLETT.

335. **Economics of Food Distribution.** Same as Horticulture 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail

distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. KELLY.

337. **Economic History of American Agriculture.** Same as Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. SCHWEITZER.

341. **Agricultural Statistics.** Statistical methods applied to agricultural economics including graphic presentation, frequency distribution, inference and probability, time series analysis, index numbers, analysis of variance, regression, and correlation. ½ unit. WEST.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. ¾ or 1 unit. Prerequisite: Economics 103 or 108. SCHMIDT.

370. **Family Economics.** Same as Home Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

Rural Sociology

COURSES FOR GRADUATES

407. **Population Studies and Demographic Analysis.** Same as Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections; relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

477. **Rural Community Organization and Development.** Same as Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of rural community organization; the process of community development as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

487. **Special Problems in Rural Sociology.** Same as Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

AGRICULTURAL EDUCATION

This program leads to the Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of vocational agriculture, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Educational Psychology 311 and 312 and two of the following courses:

History and Philosophy of Education 301, 302, 303, 304. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5. See pages 18 to 22.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall; Professor Lloyd J. Phipps, 357a Education Building; and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

(Including Agricultural Mechanization)

The Department of Agricultural Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees with a major in agricultural engineering. The student may specialize in field power and machinery (soil dynamics, tillage and earthmoving, operations analysis, dynamics of particles and mechanisms, accelerated drying, and vehicle stability); soil and water mechanics (hydraulics of structures, agricultural hydrology, drainage, mechanics of erosion, and water resources planning); farm structures (structural analysis and design, environmental control, air contaminates, and waste disposal); or electric power and processing (system analysis for farmstead mechanization, crop processing, and physical properties of agricultural products).

The grade-point average required for admission to graduate study is 4.0 for the last sixty hours of undergraduate work; however, applications of those with averages below 4.0 but above 3.75 are reviewed individually by the departmental graduate committee and admission may be recommended if credentials are satisfactory.

Candidates for the master's degree must have the equivalent of the undergraduate curriculum at the University of Illinois.

Candidates for the Doctor of Philosophy must fulfill all the standard requirements of the Graduate College as noted on pages 42 to 45. The program provides for a major in agricultural engineering with a minor in other graduate departments of engineering, mathematics, physics, including soil physics, or other disciplines in the physical sciences.

Opportunity for independent study and research is an important part of both the Master of Science and the doctorate programs. Research opportunities are available in both the Agricultural and Engineering Experiment Stations. For the master's degree, a thesis involving an analytical or experimental investigation and satisfying about one-fourth of the credit for the program is normally required.

Inquiries concerning graduate work should be directed to Frank B. Lanham, Head of the Department, 245 Agricultural Engineering Building.

GRADUATE FACULTY

Professors: F. B. Lanham (Head of Department), H. H. Beaty, E. L. Hansen, R. C. Hay, B. A. Jones, Jr., J. W. Matthews, E. F. Olver, J. A. Weber, R. R. Yoerger.

Associate Professors: W. Bowers, B. J. Butler, J. O. Curtis, R. N. Fenzl, D. R. Hunt, G. C. Shove.

Assistant Professors: H. P. Bateman, D. L. Day, R. F. Espenschied.

Agricultural Engineering

COURSES FOR GRADUATES

400. Research Orientation. Discussion of the philosophy and methods of research, thesis preparation, and publication of research findings. No credit.

436. Dynamics of Farm Machine Elements. Advanced study of the dynamics of farm machine elements with specific reference to functional operation, stresses, and fatigue life. 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. Yoerger.

446. Dynamics of Tillage, Traction, and Earthmoving. Relationship of soil parameters to forces acting on tillage tools, earthmoving components, and traction devices; stress strain relationships in soil, failure patterns, and pulverization; speed effects, energy requirements, power trains, and model simulation. 1 unit. Prerequisite: Bachelor of Science degree in engineering or consent of instructor. Weber.

490. Seminar. Presentation and discussion of current research and literature in agricultural engineering. ¼ unit.

496. Problems in Agricultural Engineering. Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. 1 unit. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Instrumentation and Measurements. Same as Mechanical Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science. Yoerger.

336. Design of Agricultural Machinery. Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. ½ unit. Prerequisite: Mechanical Engineering 224; Agriculture Engineering 236. Hunt.

346. Tractors and Prime Movers. Engineering aspects of design and application of tractors for farm, construction, and military use; thermodynamics of engines, turbines, and other power units; measurement of power and efficiencies, transmission of power, traction, stability, and hydraulic circuity. ¾ unit. Prerequisite: Mechanical Engineering 209, Agricultural Engineering 146, or equivalent. Weber.

356. Soil Conservation Structures. Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops, and practices in soil conservation and flood control. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235; Agricultural Engineering 277 or equivalent. Fenzl.

357. Land Drainage. The design, construction, performance, and maintenance ol surface tile and open ditch drainage systems. ½ unit. Prerequisite: Theoreticaf and Applied Mechanics 235. Jones.

376. **Advanced Design of Farm Structures.** Timber, steel, and concrete building design, with emphasis on structures for agricultural production. ½ unit. Prerequisite: Civil Engineering 262; Agricultural Engineering 277 or equivalent. CURTIS.

387. **Agricultural Process Engineering.** Principles, design factors, equipment, and controls of systems for drying, refrigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. ½ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. SHOVE.

396. **Special Problems.** An agricultural problem is selected for study, investigation, and report wherein a satisfactory solution requires a strong background in engineering education. ½ unit. Prerequisite: Senior standing in engineering. STAFF.

Agricultural Mechanization

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** An agricultural problem with engineering implications is selected for study, investigation, and report wherein a satisfactory solution does not require a background in engineering education. For non-engineering students only. ½ unit. Prerequisite: Minimum grade-point average of 3.5; consent of instructor and head of department. Specific approval of the associate dean in advance of registration is required for a second special problems course. STAFF.

331. **Farm Machinery Technology.** Application, functional operation and management of tillage, planting, chemical application and harvesting machinery, incorporating current engineering, agronomic, and biological research results. For students presently in or preparing for teacher training or extension education. ¾ unit. Prerequisite: Agricultural Mechanization 112 or 221. YOERGER.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ¾ unit. HANSEN.

381. **Electro-Mechanical Agricultural Systems.** Application of electric power and mechanical equipment to livestock production, crop conditioning, and materials handling systems for efficient use of time, power, and labor. Principles of planning materials handling systems; requirements for environmental control in agricultural production; electric controls circuits; and factors affecting drying, cooling, and processing of crops. ¾ unit. Prerequisite: Agricultural Mechanization 281 or graduate standing in agriculture. OLVER.

AGRONOMY

The Department of Agronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop production, biometry, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis, morphology and classification, management, physical and colloidal chemistry, physical edaphology, physics.

The student must show promise of achievement in his chosen field, must have a grade-point average of 3.75 or higher for the last sixty semester hours of work completed, and must be approved by the Department of Agronomy. For students having grade-point averages below 4.0 but above 3.75, only those having unusually strong training in the basic sciences are considered for admission.

Adequate preparation for graduate work in soils includes courses in physics,

chemistry, geology, microbiology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A pamphlet giving specific prerequisites and requirements may be obtained from the head of the Department of Agronomy.

A candidate for the Master of Science must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy.

GRADUATE FACULTY

Professors: M. D. Thorne (Head of Department), S. R. Aldrich, D. E. Alexander, A. H. Beavers, A. W. Burger, E. B. Earley, J. B. Fehrenbacher, J. W. Gerdemann, J. E. Gieseking, H. H. Hadley, R. H. Hageman, J. B. Hanson, J. R. Harlan, C. N. Hittle, A. L. Hooker, J. A. Jackobs, R. W. Jugenheimer, A. Klute, L. T. Kurtz, J. R. Laughnan, E. R. Leng, S. W. Melsted, R. T. Odell, J. W. Pendleton, M. B. Russell, W. O. Scott, F. W. Slife (Associate Head of Department), F. J. Stevenson, E. H. Tyner.

Associate Professors: R. L. Bernard, C. M. Brown, S. G. Carmer, J. W. Dudley, E. L. Knake, R. J. Miller, D. B. Peters, B. R. Sabey, R. D. Seif, R. O. Weibel, L. F. Welch, C. M. Wilson, J. T. Woolley.

Assistant Professors: R. L. Jones, R. J. Lambert, E. B. Patterson, E. C. A. Runge, Evelyn J. Weber.

COURSES FOR GRADUATES

400. **Seminar.** Discussions of current literature in crops and soils. Required of all graduate majors in agronomy. No credit. Staff.

402. **Chemical Properties of Soil: Their Relations to Soil Development and Plant Growth.** Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. 1 unit. Prerequisite: Agronomy 101 and Chemistry 101, 105, and 122, or equivalent. Miller.

403. **Genesis, Morphology, and Classification of Soils.** Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions; classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Agronomy 301 or consent of instructor. Fehrenbacher.

405. **Colloidal Chemistry of Soils.** Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Gieseking.

411. **Soil Physics.** The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341 or equivalent. Klute.

412. **Soil Organic Matter.** Basic considerations in organic matter transformation; geochemistry of organic matter; nature and origin of humic substances; reactions of organic matter in soils and sediments. Lectures, discussions, and assigned reading. Offered in 1967-1968 and in alternate years. 1 unit. Prerequisite: Agronomy 309 or consent of instructor. Stevenson.

414. **Physical Chemistry of Clays and Soils.** Same as Mining Engineering and Ceramic Engineering 414. The application of physical chemical principles and concepts to

surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor.

422. **Pasture, Range, and Soil Conservation Research.** Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. 1 unit. Prerequisite: Agronomy 121, 321, or 322. JACKOBS.

423. **Cytogenetic and Evolutionary Basis of Plant Breeding.** Nature and origin of crop species; genetic and cytogenetic basis for developing special plant materials and the use of such materials in breeding programs. Emphasis on discontinuous variation. 1 unit. Prerequisite: Agronomy or Horticulture 323, or equivalent, or consent of instructor. HADLEY, HITTLE.

424. **Mineral Nutrition of Plants.** Same as Botany and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

429. **The Evolution of Agricultural Economies.** Same as Anthropology and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. C. S. ALEXANDER, STAFF.

440. **Design and Analysis of Biological Experiments, I.** Same as Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. SEIF.

441. **Design and Analysis of Biological Experiments, II.** Same as Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 441. A continuation of Agronomy 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Agronomy 440 or equivalent. CARMER.

442. **Quantitative Aspects of Plant Breeding.** A study of the theoretical bases for plant breeding procedures with special emphasis on the relationship between type and source of genetic variability, mode of reproduction, and effectiveness of different selection procedures. 1 unit. Prerequisite: Agronomy 323 or equivalent; Agronomy 441 or equivalent. DUDLEY.

499. **Thesis Research.** 0 to 4 units.

(a) Soils. ALDRICH, BEAVERS, FEHRENBACHER, GIESEKING, JONES, KLUTE, KURTZ, MELSTED, MILLER, ODELL, PETERS, RUNGE, SABEY, STEVENSON, TYNER, WELCH.

(b) Crops. ALEXANDER, BERNARD, BROWN, BURGER, CARMER, DUDLEY, EARLEY, GERDEMANN, HADLEY, HAGEMAN, HANSON, HARLAN, HITTLE, HOOKER, JACKOBS, KNAKE, LAMBERT, LAUGHNAN, LENG, PATTERSON, PENDLETON, SCOTT, SEIF, SLIFE, WEBER, WEIBEL, WILSON, WOOLLEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Special Problems.** Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit for this course. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

301. **Soil Survey with Emphasis on Illinois Soils.** Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois and the cause of these soil differences; the influences of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative soils. Field trips; estimated cost $10.00. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. Ray.

303. **Soil Fertility.** Influence of chemical and microbiological properties of soils on crop production; rhizobial fixation and other fertility effects of crop sequence; fertilizer needs, sources, materials, and applications. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101.

304. **Soil Management and Conservation.** Influence of physical properties of soils on crop production; roles of drainage, tillage, crop sequence, and soil characteristics in land management. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. Hinesly.

309. **Intermediate Soil Science, I.** Genesis, organic matter, microbiology, and mineralogy of soils. This course, if followed by Agronomy 310, is intended to provide a science-based treatment of the field of soil science. Credit is not given for Agronomy 309 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100; Chemistry 122 and 133; Microbiology 100 and 101; two 200- or 300-level courses in plant science; credit or registration in Physics 101. Kurtz, Staff.

310. **Intermediate Soil Science, II.** Soil fertility, soil physics, and soil-plant-atmosphere relationships. This course with Agronomy 309 is intended to provide a science-based treatment of the field of soil science. Credit is not given for Agronomy 310 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100; Chemistry 122 and 133; two 200- or 300-level courses in plant science; credit or registration in Physics 102 and Mathematics 132 or 133. Kurtz, Staff.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent.

313. **Soil Mineral Analysis.** Specialized analytical procedures for determinations of soil minerals and their properties; mineralogy of soils and relationships to soil genesis and fertility. 1 unit. Prerequisite: Agronomy 101 or consent of instructor. Beaver, Jones.

321. **Ecological and Physiological Factors Affecting Crop Production.** The environmental requirements of crop plants and their physiological bases; the adequacy of the environment provided by crop land in the United States as a function of management, soils, and climate; and distribution and yield of selected crops as a function of environment. ¾ unit. Prerequisite: Botany 100; Chemistry 132 or 133. Hanson.

322. **Forage Crops and Pastures.** Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. ½ unit. Prerequisite: Agronomy 121. Jackobs.

323. **Priniciples of Plant Breeding.** Same as Horticulture 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, and the maintenance of high quality seed stocks. Field trips; estimated cost $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. Staff.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. ½ unit. Prerequisite: Agronomy 121. Slife.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Computer Science 365. A study of methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. 1 unit. Prerequisite: Computer Science 101 and a course in statistics or statistical methods, or consent of instructor. Carmer.

377. **Diseases of Field Crops.** Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. Offered in 1967-1968 and in alternate years. ¾ unit. Prerequisite: Plant Pathology 204 or equivalent. Hooker.

ANIMAL SCIENCE

The Department of Animal Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Animal Science. Research may be pursued in the following areas of specialization: (1) population and immunogenetics, (2) physiology of reproduction including endocrinology, (3) animal nutrition, (4) nutritional biochemistry, and (5) meats technology. In addition, a student who expects to terminate the graduate program at the master's level may pursue work in animal production. Beef cattle, poultry, sheep, swine, and a wide variety of laboratory animals are available for use in conducting research in the above areas.

The minimum grade-point average for admission to graduate study in animal science is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Courses in biological and physical sciences and mathematics are essential preparation for graduate work in any specialized area of animal science. Candidates specializing in the areas of animal nutrition or nutritional biochemistry must have training equivalent to one five-hour course each in quantitative analysis and organic chemistry; a course in physical chemistry also is strongly recommended. Candidates specializing in meats technology should have undergraduate training in meat evaluation, use, and/or processing, and in microbiology. Students lacking adequate background to register in graduate courses at the University of Illinois are expected to remove course deficiencies during the first year of graduate study.

GRADUATE FACULTY

Professors: H. M. Scott (Acting Head of Department), D. E. Becker, H. H. Draper, R. M. Forbes, U. S. Garrigus, A. H. Jensen, J. Kastelic, S. P. Mistry, A. V. Nalbandov, H. W. Norton, B. A. Rasmussen.

Associate Professors: D. J. Bray, P. J. Dziuk, E. E. Hatfield, G. A. Leveille.

Assistant Professors: W. W. Albert, B. G. Harmon, F. C. Hinds.

COURSES FOR GRADUATES

400. **Presentation of Experimental Results.** Preparation of technical material for oral or written presentation. ¼ unit. Dziuk.

401. **Topics in Ruminant Meat Animal Research.** A critical review and evaluation of certain aspects of ruminant nutrition and physiology with emphasis on techniques and procedures currently employed in research and the resultant application of research results to current as well as future meat animal production. Prerequisite: Consent of instructor. 1 unit. GARRIGUS, HINDS.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. ½ unit. Prerequisite: Consent of instructor. GARRIGUS.

403. **Technics and Topics in Animal Research.** Discussion and study of literature pertaining to animal research; application of experimental technics; special topics; review of research in current problem areas. ½ unit. Prerequisite: Consent of instructor. BECKER.

404. **Poultry Nutrition.** A review of the current literature in nutrition and its applicability to the avian species. ½ unit. Prerequisite: Consent of instructor. SCOTT.

405. **Advanced Animal Genetics.** Genetic theory, analysis of animal breeding problems, genetic results of selection, and different systems of breeding. 1 unit. Prerequisite: Animal Science 305 or equivalent. NORTON.

406. **Physiology of Reproduction.** Same as Zoology 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. NALBANDOV.

407. **Laboratory Methods in Animal Genetics.** ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NORTON.

408. **Laboratory Methods in Physiology of Reproduction.** Same as Zoology 408. ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NALBANDOV.

410. **Research Methods in Animal Science.** Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. ¼ to 1 unit; may be repeated for credit not to exceed a total of one unit. Prerequisite: Consent of instructor. BECKER, GARRIGUS, SCOTT, STAFF.

411. **Population Genetics and Animal Breeding.** Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. **Advanced Endocrinology.** Same as Dairy Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. ½ unit; may be repeated for credit not to exceed a total of two units. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

420. **Comparative Nutrition.** Physiological aspects of the nutrition of higher animals and man, including the digestion, utilization and function of nutrients, and the effects of dietary deficiencies. 1 unit. Prerequisite: Chemistry 350 and 355. FORBES, MISTRY.

421. **Topics in Nutritional Biochemistry.** Biochemical aspects of the nutrition of higher animals and man, with emphasis on the function and metabolism of nutrients. 1 unit. Prerequisite: Animal Science 420. DRAPER, MISTRY.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical

methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. CARMER.

441. Design and Analysis of Biological Experiments, II. Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Animal Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Animal Science 440 or equivalent. CARMER.

463. Radioisotopes in Biological Research: Principles and Practice. See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

496. The Use of Carbon-14 in Labeling Techniques. Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. CONRAD, NYSTROM.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Beef Production. The principles of feeding and management of beef cattle; financial aspects of beef production; diseases, parasites, and breeding difficulties of beef cattle. Lectures, demonstrations, and discussions. ¾ unit. Prerequisite: Animal Science 220 or equivalent. ALBERT.

302. Sheep Production. The sheep and wool industries; principles and practices of various phases of production. ¾ unit. Prerequisite: Animal Science 220 or equivalent. GARRIGUS.

303. Pork Production. The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. ¾ unit. Prerequisite: Animal Science 220 or equivalent. BECKER, HARMON, JENSEN.

304. Poultry Management. Application of scientific principles to the management of poultry. Undergraduate students may register for four hours credit with laboratory or for three hours credit without laboratory. ¾ unit. Prerequisite: Animal Science 220 or equivalent. BRAY, SCOTT.

305. Genetics and Animal Improvement. Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. ¾ unit (Summer Session, ½ unit). Prerequisite: Animal Science 110 or equivalent. DEFRIES, RASMUSEN, TOUCHBERRY.

330. Reproduction and Artificial Insemination of Farm Animals. Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit. Prerequisite: Zoology 104 and either Dairy Science 100 or Animal Science 100. GRAVES.

332. Livestock Marketing. Same as Agricultural Economics 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated cost, $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

ANTHROPOLOGY

The Department of Anthropology offers graduate work leading to the Master of Arts and Doctor of Philosophy. Course work is available in the main branches of cultural anthropology, including linguistics, and in physical anthropology. Special training is available in a number of world areas—South and Southeast Asia, Africa, Indonesia, Latin America, North America, Russia, and Siberia. Among the fields in which the department has specialized are: processes of culture growth and change; urban anthropology; personality and culture; political anthropology; human ecology; ethnolinguistics; field research techniques. Investigations in American archaeology include the Southwest, the Midwest, Eastern United States, and South America, with work in the Midwest facilitated by the programs of the Illinois Archaeological Survey. Opportunities for field work in the various branches of anthropology are regularly provided.

Applicants for admission as first-year graduate students are required to have a grade-point average of 4.0 for the last sixty hours of undergraduate training. Exceptions may be made by a special committee for those applicants with a grade-point average between 3.5 and 4.0, particularly if the student displays substantial evidence of having acquired special skills or of having had significant experience relevant to anthropology. A student who does not have an undergraduate major in anthropology or its equivalent may be permitted to register for graduate courses, but will be required to make up any deficiencies.

A detailed statement of requirements for higher degrees and additional information about departmental programs and policies is available on request.

A candidate must demonstrate ability to read two languages. He may choose two from Group A, or one from Group A and one from Group B. *Group A:* German or Dutch, Russian, Japanese, Chinese; *Group B:* French, Italian, Spanish, Portuguese. In all cases, the candidate must obtain the approval of his adviser and the department, the criteria of approval being that the languages must be research tools and they must contribute to the candidate's graduate program. The department will consider individual applications to take the one language high-level proficiency examination (see page 43).

With the approval of the adviser and the department, a candidate may satisfy the minor requirement by taking courses within the department. Approval is given only in those cases in which a subfield, such as biological anthropology or anthropological linguistics, constitutes an essential part of the candidate's overall program.

GRADUATE FACULTY

Professors: E. M. Bruner (Acting Head of Department), J. B. Casagrande, O. Lewis, J. C. McGregor, D. B. Shimkin, J. H. Steward.

Associate Professors: D. W. Lathrap, F. K. Lehman, D. W. Plath.

Assistant Professors: A. H. Jacobs, A. H. Rohn, Jr., J. F. Yegerlehner.

Instructor: C. J. Bareis.

COURSES FOR GRADUATES

401. **General Anthropology, I.** A comprehensive survey of the various subfields of anthropology, with special reference to contemporary trends in theory and method: anthropology among the sciences, historical perspectives, human evolution and variation, the nature of culture, cultural evolution, the ecological approach, archaeology, linguistics. 1 unit. Prerequisite: Twelve hours of anthropology or consent of instructor.

402. **General Anthropology, II.** Continuation of Anthropology 401. Cultural typology, technology and economic organization, social structure, political organization, religion, art, personality and culture, processes of culture change, acculture-

ration, applied anthropology, the logic of anthropological research, field methods. 1 unit. Prerequisite: Anthropology 401 or consent of instructor.

429. **The Evolution of Agricultural Economies.** Same as Agronomy and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. LATHRAP, STAFF.

440. **Problems in Physical Anthropology.** A seminar designed to involve students in the theoretical and methodological approaches to problem areas in physical anthropology. 1 unit. May be repeated for additional credit. Prerequisite: Anthropology 340; consent of instructor.

450. **Seminar in Anthropology.** Analysis of selected topics of special interest in anthropology. 1 unit. Students may reregister in this course up to a total of two units. STAFF.

451. **Social Structure.** This course is intended to acquaint the student with the descriptive techniques and methods of structural and functional analysis currently employed by social anthropologists in the study of primitive social groups and their methods of operation. 1 unit. Prerequisite: Consent of instructor. STAFF.

452. **Research Problems in Archaeology.** Seminar oriented to current research problems in archaeology, designed to acquaint students with theoretical and methodological aspects of particular problems, and to develop a critical perspective of archaeological research. Course may be repeated for additional credit. 1 unit. Prerequisite: Consent of instructor. MCGREGOR.

453. **The Formal Analysis of Kinship Systems.** A survey of a variety of the world's systems of kinship, marriage, and family organization. Concentration on the distinctive properties of kinship systems as a species of social structure, on the formal apparatus for describing and understanding them and their functions, and on the theory of kinship that arises from the use of such formal apparatus. ½ or 1 unit. Prerequisite: Consent of instructor. LEHMAN.

460. **Theories and Methods in Anthropology.** A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. 1 unit. CASAGRANDE.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. 1 unit. Prerequisite: Consent of instructor. STEWARD.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. 1 unit. Prerequisite: Anthropology 461 or consent of instructor. STEWARD.

463. **Seminar on Field Methods and Research Designs in Cultural Anthropology.** Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and comparative studies on both the tribal and peasant levels are examined. 1 unit. Prerequisite: Consent of instructor. STAFF.

471. **Personality, Culture, and Society.** A seminar on selected topics in culture and personality. The emphasis varies from year to year; possible topics include the interrelationship between social systems and personality, national character studies, comparative education, cultural learning and transmission, the psychological cocomitants of cultural change. 1 unit. Prerequisite: Consent of instructor. STAFF.

489. **Readings in Anthropology.** Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interests of the student. ½ or 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. STAFF.

490. **Individual Topics in Anthropology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study are approved by the adviser and the staff member who supervises the work. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** Preparation of theses. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** Same as Linguistics 300. An introduction to the science of descriptive linguistics. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

309. **Field Methods in Linguistics.** Same as Linguistics 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. LEHMAN, YEGERLEHNER.

310. **Advanced Field Methods in Linguistics.** Same as Linguistics 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Anthropology 309 or equivalent. LEHMAN, YEGERLEHNER.

315. **Area Studies in Ethnomusicology.** Same as Music 317. A seminar devoted to intensive study in the music of one specific culture, e.g., Japan, China, Indonesia, India, the Near East, African and New World Negro, European and American folk cultures, American Indian. ½ unit. Prerequisite: Senior standing in music or consent of instructor. NETTL.

316. **Introduction to Music of the World's Cultures.** Same as Music 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. **Languages of the World.** Same as Linguistics 317. A survey of the main language families of the world from both genetic and typological points of view. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

320. **Political Anthropology.** The comparative and analytic study of the political systems of representative non-Western peoples. Attention is also paid to the transformations of native political institutions as consequences of colonialism and political modernization. ½ or 1 unit. Prerequisite: Anthropology 103. JACOBS.

330. **Processes of Culture Change.** The impact of modern cultures on native peoples, comparative study of the mechanisms underlying the transition to modernity in the new nations, and the psychologican and structural aspects of acculturation and urbanization. ½ or 1 unit. Prerequisite: Anthropology 103 or consent of instructor. BRUNER.

331. **Aboriginal North America.** The course deals with three major topics: (1) the nature and structure of aboriginal North America as a cultural province and its ecological base; (2) distinctive and common features of American Indian cultures; (3) responses to the stresses of white contact. Selected type cultures and their adaptations to varying ecological situations are examined in detail. A student

may not receive credit for both Anthropology 270 and 331. ½ or 1 unit. Prerequisite: Anthropology 260. SHIMKIN.

332. **Native Cultures of South America.** A survey of the nature and variability of the aboriginal Indian cultures of South America. Special emphasis is placed on the relationship between various typical cultures and their ecological setting. Sample cultures illustrating the full range of community stability, population density, and social complexity are studied. ½ or 1 unit. Prerequisite: Anthropology 260 or consent of instructor. ZUIDEMA.

340. **Human Evolution, I.** The principles of evolution, and a survey of the evolution of man and his progenitors to the Paleolithic. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

341. **Human Evolution, II.** The principles of human genetics, anthropological aspects of race and race formation, and hereditary and environmental factors in the biological variation of modern man. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

343. **Introduction to Primate Morphology and Behavior.** A survey of primate social behavior and the classification, morphology, and distribution of living and extinct species. Emphasis is placed on interrelationships with aspects of anthropological study. ½ or 1 unit. Prerequisite: Anthropology 340, or Zoology 101 or 104, or consent of instructor.

349. **South American Culture History, I.** An examination of the factors influencing the initial peopling of South America, the spread and diversification of hunting and gathering economies, and the development and spread of the Tropical Forest cultural pattern. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

350. **South American Culture History, II.** An examination of the factors leading to the rise of civilization in the Central Andes, including the evolution of agricultural systems, the elaboration of technology, and emergence of extensive and complex political units. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

351. **Archaeological Surveying: Techniques and Applications.** Familiarization with methods used in the location and recording of archaeological sites, including techniques of mapping especially adapted to the needs of archaeology. Attention is also given to means of presenting results and interpreting data derived from this work. The course involves work both in the field and in the laboratory. 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. STAFF.

352. **Precolumbian Civilizations of Mesoamerica.** The major civilizations of Mexico and Guatemala are studied. Emphasis is placed on the growth and ramification of the several major cultural traditions and on the kinds of evidence which are available as a basis for the study of the growth of political units and their interaction. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. LATHRAP.

353. **Southwestern Archaeology.** A detailed study of one archaeological unit in the United States, covering the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MCGREGOR, ROHN.

354. **Field Techniques in Archaeology.** Participation in archaeological excavation; techniques, methods, and procedures discussed and practiced in actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

355. **Laboratory Techniques and Problems in Archaeology.** Laboratory work in the field; studying, evaluating, and writing final reports on preceding field work. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. Staff.

356. **Physical Anthropology.** The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, physiology, or introductory zoology. McGregor.

357. **Midwestern Prehistory.** A detailed study of the midwestern archaeological area covering the broad cultures with regional variations considered chronologically and stressing their interrelationships. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. McGregor.

358. **Prehistory of the Old World.** An examination of Old World prehistory showing developments and relationships between various cultural traditions and histories from the earliest times. ½ or 1 unit. Prerequisite: Anthropology 220 or consent of instructor.

359. **The Mesolithic and the Origins of Food Production in the Old World.** A continuation of Anthropology 358. Designed to give students an introduction to the Postglacial hunting communities of Europe from around 8,000 B.C., to the origins of food production, and to the domestication of animals in Europe, the Near East, and the Mediterranean basin. 1 unit. Prerequisite: Anthropology 220; consent of instructor.

360. **Peoples of Oceania.** A survey of the groups inhabiting the islands of the Pacific, including Australia. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Eyde.

361. **Peoples and Cultures of Mexico and Guatemala.** A survey of the people and cultures of Middle America with special emphasis upon Mexico and Guatemala. This course begins by placing Middle America geographically, historically, and culturally within the broader Latin American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Lewis.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from archaeological and historical records as well as from contemporary ethnological studies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. Staff.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. Staff.

366. **Peoples of Southeast Asia and Indonesia.** The culture, history, economy, social system, political organization, and character structure of the peoples of Indonesia, Malaya, and the Philippines. Attention also is paid to contemporary economic and political problems of the newly independent nations seen from an anthropological perspective. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. LEHMAN.

367. **Peoples and Cultures of Africa.** A survey of the cultures of Africa with particular emphasis on the ecological and historical development of culture types and the behavior associated with them. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. JACOBS.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

369. **Introduction to Human Ecology.** Same as Geography, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Language, Culture, and Society.** Same as Communications and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

371. **Culture and Personality.** A cross-cultural comparative analysis and evaluation of current theories of culture and personality formation. The course is concerned with the socio-cultural matrix in which personality develops, as well as with the application of personality concepts, especially those derived from psychoanalytic theory, to the study of primitive and modern society. ½ or 1 unit. Prerequisite: An introductory course in anthropology, sociology, or psychology, or consent of instructor. BRUNER.

372. **The Anthropological Study of Art.** A review of the anthropological approach to art with emphasis on structural analysis and the relationship of the artist to his culture. Problems of stylistic development are considered within the framework of cultural dynamics, and a survey of the major art style areas outside the Western tradition and the Orient is included. ½ or 1 unit. Prerequisite: Three hours of anthropology or consent of instructor. LATHRAP.

373. **Human Development in Cross-Cultural Perspective.** Same as Psychology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, sociology, or psychology, or consent of instructor.

374. **Problems in Human Ecology.** Same as Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit.

Prerequisite: Anthropology, Georgraphy, Health Education, Physiology, Sociology, or Zoology 369. JACOBS, STAFF.

375. **Peoples and Cultures of the Near and Middle East.** A general survey of the bionomy of the area, followed by a description and analysis of the cultural patterns and social systems of the major ethnolinguistic divisions—Semitic, Iranian, Turkic —and the interrelating function of Islam. Particular consideration given to language, folklore, belles-lettres, music, architecture, crafts, etc., from an anthropological standpoint. Thereafter, selected ethnographies are considered for comparative purposes. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

380. **Applied Anthropology.** The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in nonindustrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

381. **Russian Culture History and Ethnology.** Same as Geography 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. **Siberian Culture History and Ethnology.** Same as Geography 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. **Cultures of Modern East Asia.** Human life in the cultural setting of East Asia since the early nineteenth century. This course centers upon problems of adapting traditions and institutions to the needs of modern industrial civilization; geographical focus varies. 1 unit. Prerequisite: An introductory course in anthropology or East Asian history, or consent of instructor. PLATH.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural and urban design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles); advanced structural theory and design; building construction; history of architecture.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture is 3.75. Applicants with averages below 3.75 but above 3.5 are considered on an individual basis. All applications for admission should be accompanied by samples of the applicant's work in structures and design.

Students are expected to follow one of the recommended area programs unless approval is obtained from the chairman of the department for a special program. A minimum of eight units is required for the master's degree.

GRADUATE FACULTY

Professors: J. H. SWING (Chairman of Department), J. S. BAKER, L. J. BRIGHTBILL, G. T. CLAYTON, P. H. COY, W. ENG, G. GUEVREKIAN, H. L. HORNBEAK, R. A. JONES, A. K. LAING, D. B. LINDSAY, R. P. LINK, C. B.

LOOKER, A. NOTARAS, J. G. REPLINGER, R. J. SMITH, S. J. Y. TANG, E. F. TOTH, A. R. WILLIAMS, H. C. YOUNG.
Associate Professors: E. M. FARNHAM, S. T. LANFORD, W. H. LEWIS, C. T. MARFORT.

COURSES FOR GRADUATES

417. Development of Contemporary Architectural Thought. An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, Mies van der Rohe, Viollet-le-Duc, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, Serlio, and Vitruvius. ½ unit. Prerequisite: Consent of instructor. LAING.

431. Advanced Theory of Architecture. A review of principles of architecture and urban design; factors in programming architectural requirements; design development; analysis and criticism. ½ unit. Prerequisite: Consent of instructor. WILLIAMS.

432. Seminar in Architectural Design. The analysis and criticism of selected buildings. Individual reports and discussion. ½ unit. Prerequisite: Architecture 431 or consent of instructor. WILLIAMS.

435. Advanced Architectural Design. Advanced study of space relationships and other elements of architectural design from urban scale to that of individual buildings, including the integration of structural, mechanical, and interior design. Joint studies in urban design with graduate students in urban planning and landscape architecture. 2 units. Prerequisite: Bachelor's degree in architecture (general option) or consent of instructor. WILLIAMS.

452. Advanced Theory and Design of Steel Structures. Theory and design in bending, buckling, torsion, and combined stresses in beams and columns. Study in design and behavior of connections; composite constructions; light gage steel construction analysis. Design and economy of simple and complex building frames. 1 unit. Prerequisite: Architecture 348 or consent of instructor. TANG.

454. Advanced Structural Design in Reinforced Concrete. Critical review of the methods and specifications involved in the design and behavior for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way and flat-slab floor construction; columns and footings; torsion; plastic theory of design; economy and continuity in building design. 1 unit. Prerequisite: Architecture 358 or consent of instructor. TANG.

481. Advanced Building Construction. Characteristics and relationships of the multiple components of the building industry: labor, general and specialty contracting, the manufacture and distribution of materials, finance, government, building ownership and operation; building costs and cost analysis; studies of selected building materials, products, and construction techniques. ½ unit. Prerequisite: Consent of instructor.

491. Special Problems in Building Construction. Individual direction in the investigation of selected topics in building construction. ½ to 2 units. Prerequisite: Credit or registration in Architecture 481.

493. Special Problems in Structural Theory and Design. Individual or group investigation and study in architectural engineering application. Research in economy and design in correlation with architectural, mechanical, and structural requirements. Options: foundation design; prestressed concrete design; plastic design in steel; structural planning; wood construction; architectural research laboratory. ½ to 4 units. Prerequisite: Consent of instructor. HORNBEAK, TANG, STAFF.

494. Special Problems in Architectural Design. Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. ½ to 2

units. Prerequisite: Architecture 435 or consent of instructor. Williams, Visiting Critics.

496. **Special Problems in Architectural History.** Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. ½ to 2 units. Prerequisite: Architecture 417 or consent of instructor. Laing.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Architectural Design.** Continued study of architectural design emphasizing (a) complex site development and composition, and (b) definitive design and refinement of detail for one of the plan components. Preparation of senior thesis program. 2 units. Prerequisite: Architecture 236. Staff.

338. **Architectural Design.** Individual research and comprehensive design solution of a selected architectural project, with special emphasis on site development, integration of structures; mechanical equipment, illumination, and acoustics. 2 units. Prerequisite: Architecture 337. Staff.

339. **Urban Housing.** Study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. ½ unit. Prerequisite: Consent of instructor. Jones.

347. **Theory of Structures.** Advanced problems in the analysis of statically determinate structures; general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. 1½ units. Prerequisite: Architecture 257; Mathematics 142. Hornbeak.

348. **Advanced Structures.** Advanced topics on design of structural members and connection. Analysis and design of continuous structures, rigid frames, and tall buildings. 1½ units. Prerequisite: Architecture 347; credit or registration in Architecture 358. Coy.

358. **Advanced Reinforced Concrete.** Reinforced concrete building design. 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348. Tang.

ART

The Department of Art offers graduate work leading to the degrees listed below.

For admission, an applicant must be a graduate of an accredited college or university with at least a bachelor's degree and with a grade-point average of 3.5 or above; he must be accepted by the graduate committee of the Department of Art after examination of his transcripts, as well as examples of his work if his major is to be in a creative field. Students expecting to major in art education must have (or be eligible for) a teaching certificate in their field. Applicants are expected to have completed an undergraduate program similar to that which leads to the bachelor's degree as established at this University, with a major, or related studies acceptable to the advisers, in the field to be pursued in graduate study.

Normal residence requirement is two years for the Master of Fine Arts and one year for the Master of Arts, although the graduate committee may extend this requirement or increase the unit requirements if this seems warranted.

Complete descriptions of offerings and admission requirements for all degrees and instructions for applying for admission and grants may be had by writing for application forms and the brochure on Graduate Programs in Art, to Warren F. Doolittle, Chairman of Graduate Programs in Art, Department of Art, 140 Fine and Applied Arts Building.

Master of Fine Arts with Design Major (Graphic Design or Industrial Design). Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, six to ten units; art history (selected from the group Art 304 through 328), three-fourths unit to one and one-half units; electives or interdisciplinary subjects as determined in consultation with the adviser, two to six units. A thesis is required. Students majoring in graphic design who hold one-half time teaching or research assistantships may expect correspondingly extended residence due to reduced academic load.

Master of Fine Arts with Painting and Printmaking Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 495, two to eight units; Art 497, two to eight units, one unit of which must be in intaglio; art history (two courses selected from the group Art 304 through 328), one and one-half units; electives (Art 332, 341, 351, 392, 393, 394, 491, 494; art history and/or other courses approved by the adviser), two to six units. A thesis is required.

Master of Fine Arts with Sculpture Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 496, six to ten units; art history (two courses selected from the group Art 304 through 328), one and one-half units; electives (Art 332, 333, 341, 383, 392, 393, 394, 491, 494; art history and/or academic courses approved by the adviser), two to six units. A thesis is required.

Master of Arts with Art Education Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; art history (one course selected from the group Art 304 through 328), three-fourths unit; art electives, two and one-fourth units; Educational Psychology 311, one-half unit; Educational Psychology 312, one-half unit; Secondary and Continuing Education 456, one unit; two of the following: History and Philosophy of Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required. See pages 41 and 42.

Master of Arts with Art History Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; Art 494, one unit; art history (courses selected from the groups Art 304 through 328, Art 450 through 454, and Architecture 417 and 496, with the approval of the adviser), three units minimum; Art 499 (thesis), one-half to one unit; electives (Art 492 and/or other courses approved by the adviser), one to three units. Demonstration of proficiency in a modern foreign language (preferably German or French) is also required for the degree.

Doctor of Education in Art Education. The program leading to the Doctor of Education with a major in art education is designed to provide advanced professional preparation for art educators and to develop educational leaders with a high level of art and educational competence. The program is offered jointly by the Department of Art and the College of Education.

Admission. A candidate for admission must hold a master's degree in fine arts, or art education, or the equivalent from an accredited institution. He must also have a minimum of two years' acceptable teaching experience. Admission is determined by examinations administered by the Department of Art and the College of Education, personal interviews, record of previous education and experience, and recommendations from persons who have known the candidate. Examinations administered by the Department of Art include art education, art history, and art processes. Portfolios of art work may also be required.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the Department of Art and one from the College of Education.

Residence. Minimum residence requirement is one year of uninterrupted work

during which a minimum of six units of work is successfully completed. The remaining course work may be completed during summer sessions or during the regular school year.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in art and art education and six units of credit in education. The following courses are required: Elementary Education 455, one unit; History and Philosophy of Education 405 and 410, two units; Educational Psychology 390 and 415, two units; Art 493, one unit; a course in research in art education, one unit; electives in art and art education, three units; electives in education, two units; electives, four units.

A thesis is required, but no academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of the thesis title and the preparation, submission, and publication of the thesis must be met.

GRADUATE FACULTY

Professors: J. R. Shipley (Head of Department), E. H. Betts, C. W. Briggs, L. R. Chesney, Jr., C. A. Dietemann, W. F. Doolittle, D. E. Frith, J. W. Kennedy, K. M. Lansing, R. Perlman, E. C. Rae, H. A. Schultz, M. A. Sprague, R. A. von Neumann, A. S. Weller, E. J. Zagorski, N. Ziroli.

Associate Professors: N. McFarland, Ann Perkins, A. R. Sinsabaugh, R. W. Sterkel, E. C. Wicks.

Assistant Professors: P. Bodnar, Minerva Pinnell, R. A. Smith.

Instructor: M. Franciscono.

COURSES FOR GRADUATES

450. Studies in Modern Art. Investigation of special problems; writings of artists and critics; preparation of critical reports. 1 unit. Prerequisite: Consent of instructor.

451. Studies in American Art. Investigation of special problems; historical development of the study of American art; techniques of conservation and restoration. 1 unit. Prerequisite: Consent of instructor.

452. Seminar in Chinese Art. Investigation of selected phases, concepts, and problems of the art of China; intensive reading and reports. 1 unit. Prerequisite: Art 328 or consent of instructor.

453. Seminar in Japanese Art. Investigation of selected phases, concepts, and problems of the art of Japan; intensive reading and reports. 1 unit. Prerequisite: Art 327 or consent of instructor.

454. Seminar in Ancient Art. Research seminar in problems selected from the art of ancient Mediterranean area. 1 unit. Prerequisite: At least one of the following: Art 304, 305, 306, 307, or equivalent; reading knowledge of French and German.

467. Graphic Design Laboratory. Individually directed research in problems of visual design with emphasis on the understanding of recent developments in nonverbal communication and the utilization of contemporary graphic processes. 1 to 3 units. Prerequisite: Bachelor of Arts or Bachelor of Fine Arts in visual communications or related equivalent.

477. Industrial Design Laboratory. Individually directed research in the drafting room or workshop with concentration in industrial design. 1 to 3 units. Prerequisite: Bachelor of Fine Arts in industrial design or equivalent.

491. Special Problems. Individual direction in research and in creative activity; thesis. ½ to 2 units.

492. **Individual Readings in History of Art.** Directed readings in special fields or aspects of history of art not provided in depth by the current course offerings. ½ to 1 unit. Prerequisite: Consent of instructor.

493. **Seminar: Introduction to Methods and Criticism.** 1 unit.

494. **Seminar: Studies in the Development of Art History and Criticism.** The relation of art history and criticism; changing standards and criteria; intensive reading of selected critical works; the writing of art criticism. 1 unit. Prerequisite: Consent of instructor.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. ½ to 3 units.

496. **Sculpture Laboratory.** Experience at a professional level in sculptural techniques including metals casting, welding, stone carving, wood carving, clay modeling, and ceramic sculpture, with emphasis on the development of creative achievement. 1 to 3 units. Prerequisite: Graduate standing in art and permission of the departmental graduate committee.

497. **Print Wookshop.** Intaglio, relief, and planographic; printing, including etching, engraving, aquatint, wood, paper and plastic relief printing, and lithography. ½ to 3 units.

499. **Thesis Research.** Guidance in research and writing theses for advanced degrees. 0 to 4 units. Prerequisite: Graduate standing in history of art.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Greek Sculpture.** A survey of the development of Greek sculpture from Mycenean times to the Christian Era with analysis of the major works in relief and in the round. ¾ unit. Prerequisite: One year of art history or consent of instructor.

305. **Art of the Augustan Age.** A study of the major works of architecture, sculpture, and painting in Italy and the Roman Empire from the time of Augustus. ¾ unit. Prerequisite: One year of art history or consent of instructor.

306. **Near Eastern and Greek Art.** Architecture, sculpture, and painting of Egypt, Western Asia, Crete, and of Greece from Mycenean times through the Classical period. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

307. **Hellenistic, Roman, and Byzantine Art.** Architecture, sculpture, painting, and mosaics of the Hellenistic world, Italy and the Roman empire, and the Byzantine empire. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

308. **Early Medieval Art.** The arts of Byzantium and of Western Europe from the early Christian through the Romanesque period. ¾ unit. Prerequisite: One year of history of art.

309. **Gothic Art.** The arts of Western Europe from the end of the Romanesque period until the Renaissance. ¾ unit. Prerequisite: One year of history of art.

310. **The History of Printmaking.** The development of the various graphic processes in the hands of important printmakers from the fifteenth through the nineteenth centuries. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

318. **Latin-American Art.** Study of the more important phases and periods of the visual arts of Latin America. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

319. **Italian Art of the Seventeenth and Eighteenth Centuries.** An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

320. **Northern European Art of the Seventeenth and Eighteenth Centuries.** An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, and England during the seventeenth and eighteenth centuries, in terms of major figures and dominant stylistic developments. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

321. **Twentieth–Century Art, 1900 to 1925.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

322. **Twentieth–Century Art, 1925 to Date.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

323. **American Art to 1840.** Architecture, painting, sculpture, and minor arts of the Colonies and the United States to 1840. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

324. **American Art, 1840 to 1900.** Architecture, painting, sculpture, and minor arts of the United States. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

325. **Recent American Painting and Sculpture.** Current developments, with special emphasis on works shown in contemporary exhibitions at the Krannert Art Museum. ½ or ¾ unit. Prerequiste: One year of history of art or consent of instructor.

327. **Japanese Art.** History of Japanese art from earliest times to the twentieth century. ¾ unit. Prerequisite: One year of history of art or junior standing.

328. **Chinese Art.** History of Chinese art from earliest times to the present. ¾ unit. Prerequisite: One year of history of art or junior standing.

332. **Drawing.** Advanced drawing in several media. ½ to 1 unit. Prerequisite: Art 126 or equivalent; for graduate students, consent of departmental graduate committee.

333. **Painting.** Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts in painting and printmaking. ½ to 1 unit; may be repeated for a total of two units.Prerequisite: Art 142 or equivalent; for graduate students, consent of departmental graduate committee.

341. **Painting Materials and Techniques.** Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. ½ unit. Prerequisite: Art 142 or graduate standing in art.

351. **Advanced Sculpture Techniques.** Advanced work in various sculptural media. ½ to 1 unit. Prerequisite: Art 252 or equivalent.

383. **Print Media.** Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts in painting. ½ to 1 unit. Prerequisite: Art 284 or equivalent; for graduate students, consent of departmental graduate committee.

385. **Lithography.** Laboratory course in lithography. Course of study includes a complete development of the process, exploiting its potential as a fine art medium. ½ to 1 unit. Prerequisite: Art 286; for graduate students, consent of departmental graduate committee.

392. **Silversmithing, I.** Advanced course in design and execution of hollowware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. ½ to 1 unit. Prerequisite: Consent of instructor.

393. **Silversmithing, II.** Advanced course in design and execution of flatware and hollowware, dealing primarily with forging and seaming methods, engraving, and toolmaking. ½ to 1 unit. Prerequisite: Consent of instructor.

394. **Ceramic Design.** Ceramic design with emphasis on the development of professional style and personal expression. ½ to 2 units. Prerequisite: Art 295 or consent of instructor.

ASIAN STUDIES

A graduate minor in Asian studies is administered by the Center for Asian Studies in cooperation with various departments. It is possible for a graduate student electing this minor to concentrate on East Asia, Southeast Asia, South Asia, or the Near and Middle East, or a combination of two or more of these areas.

A candidate for a master's degree who elects Asian studies as a minor must earn at least two units of graduate credit in at least two departments from approved courses.

A doctoral candidate who elects Asian studies as a minor must earn at least four units of graduate credit in at least two departments from approved courses.

The list of the courses which may be chosen to satisfy the minor in Asian studies is available at the Center for Asian Studies, 1207 West Oregon Street, Urbana.

Also, the doctoral candiate must, prior to the completion of his course requirements for the degree, complete satisfactorily one of the following: Arabic 304, Burmese 304, Chinese 304, Hindi 304, Indonesian 304, Japanese 304, or equivalent.

Candidates should contact the Director of the Center for Asian Studies regarding additional courses which would be acceptable.

Students who do not elect an Asian studies minor but who seek knowledge of Asian affairs, cultures, and languages are invited to consult, either directly or through their advisers, with the Director of the Center or with faculty associated with the Center in order to develop programs suited to their individual needs.

The adviser for the graduate minor is Professor Solomon B. Levine, Director of the Center for Asian Studies, 1207 West Oregon Street, Urbana.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Astronomy (including radio astronomy). Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. In addition, the normal entrance requirements are as follows: (1) a bachelor's degree in astronomy, physics, electrical engineering, or mathematics, and (2) a one-year course in descriptive astronomy.

The eight units for the Master of Science may be obtained in three ways, listed as (1), (2), and (3) below. Alternative (3) is intended for students wishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be at the 400 level.

(2) Two units may be selected from approved courses in mathematics; two units may be taken in approved courses in physics; the remaining units must be taken in astronomy. At least three units must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be earned by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the Doctor of Philosophy may be obtained by writing to the Head of the Department, University of Illinois Observatory.

For information regarding applied mathematics, see page 273.

GRADUATE FACULTY

Professors: G. C. McVittie (Head of Department), G. W. Swenson, Jr., S. P. Wyatt, K. M. Yoss.

Assistant Professors: J. R. Dickel, J. B. Kaler, E. C. Olson.

COURSES FOR GRADUATES

401. Stellar Atmospheres. Physical characteristics of stellar atmospheres as derived from spectroscopic observations; radiation transfer, theory and observations of the continuous spectrum, limb darkening; formation of absorption lines, line profiles, curves of growth, relative chemical abundances; emission features; forbidden radiation. 1 unit. Prerequisite: Consent of instructor. Kaler.

403. Gaseous Nebulae and the Interstellar Medium. Distribution, structure, and spectra of nebulae; physical processes in planetary and diffuse nebulae; recombination, fluorescence, and forbidden line radiation; determination of physical parameters; nature of the interstellar medium; interstellar gas and grains; observation of interstellar medium. 1 unit. Prerequisite: Astronomy 301. Kaler.

404. Theory of Stellar Structure. Masses, luminosities, radii, and surface temperatures of stars; basic equations and stability conditions; nuclear reactions; integration of basic equations; results—initial stages, later stages, white dwarfs. 1 unit. Prerequisite: Consent of instructor. Olson.

415. Experimental Methods in Radio Astronomy. Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. 1 unit; may be taken a second time for credit. Prerequisite: Consent of instructor. Dickel, Swenson.

424. Relativity and Cosmology. Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

433. Solar System Astrophysics. Planetary orbits and perturbations; physical perturbations; physical parameters of the planets; planetary interiors, atmospheres, magnetospheres, and surface layers; the satellites; asteroids and comets; meteors, meteorites, and tektites; interplanetary grains and gas; problems of origin and evolution. 1 unit. Prerequisite: Consent of instructor. Dickel, Wyatt.

486. Constitution of the Ionosphere: An Introduction to Aeronomy. Same as Electrical Engineering 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent. Bowhill.

491. Seminar in Special Topics. 1 to 4 units. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. 0 to 3 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introductory Astrophysics. Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors; special types of stars, interstellar matter. 1 unit. Prerequisite: Physics 108. OLSON.

302. Astrophysics of the Sun. Observations of the sun at all wave lengths and application of the results to the study of the photosphere, chromosphere, and corona; structure of the atmosphere of the quiet sun; solar activity. 1 unit. Prerequisite: Astronomy 301. DICKEL.

306. Foundations of Mechanics and Gravitational Theory. Same as Aeronautical and Astronautical Engineering 306. Introduction to the dynamics of particles and rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE.

307. Celestial Mechanics. Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. 1 unit. Prerequisite: Astronomy 306 or Physics 322. MCVITTIE.

314. Observational Astronomy. Same as Civil Engineering 305. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143. WYATT.

315. Observational Techniques and Reductions. Methods of observation and reductions in photographic and photoelectric photometry, spectrophotometry, and stellar radial velocity determinations. 1 unit. Prerequisite: Astronomy 314. YOSS.

321. Stellar Systems, I. Galactic structure: the observational data; stars in the solar neighborhood; the solar motion; stellar statistics and distribution; stellar populations; interstellar matter and spiral structure; the whole galaxy. 1 unit. Prerequisite: Astronomy 102 or 210; Physics 108. YOSS.

322. Stellar Systems, II. Continuation of Astronomy 321. Galactic dynamics: stellar motions; galactic rotation; dynamics and mass distribution; stellar encounters; dynamics of interstellar matter. Galaxies: distances, structural features; groups and clusters; radio galaxies and quasars; spatial distribution and motions. 1 unit. Prerequisite: Astronomy 321. WYATT.

357. Radio Astronomy. Same as Electrical Engineering 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108. DICKEL.

366. Aeronomy: Physics of the Upper Atmosphere and Space. Same as Electrical Engineering and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 321, 342, and 381; or consent of instructor. RAETHER.

BIOCHEMISTRY

Biochemistry is a multidisciplinary field resulting from an interaction of chemistry and physics with biology. The biochemistry staff offers training in biochemistry, or molecular biology and biophysical chemistry (see below and also page 97). Programs leading to graduate degrees in biochemistry are offered in the Biochemistry Division of the Department of Chemistry and Chemical Engineering. Entering graduate students in biochemistry must therefore meet the graduate entrance requirements of that department (see page 95).

Interested students should contact the Biochemistry Division.

BIOLOGY

See descriptions and course listings under Life Sciences, page 233.

BIOPHYSICS AND BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

Biophysics is a rapidly growing field that cuts across many disciplines. An area overlapping with this and developing through interaction of chemistry and biology is that of biophysical chemistry.

Since graduate study in biophysics and biophysical chemistry involves several areas of biological and physical sciences, the Graduate College has adopted a flexible system enabling students to enter special interdisciplinary programs in these areas, thus affording them a wide range of opportunity for study and research in borderlands between the biological and physical sciences.

For the program leading to the Doctor of Philosophy in Biophysics, see descriptions and course listings under Life Sciences, pages 244 and 248.

Students majoring in chemistry or microbiology may elect to specialize in biological problems at the molecular level (see pages 97 and 241.) Students in other areas of the biological and physical sciences who wish to arrange programs of study emphasizing biophysics should direct their inquiries to the head of the major department.

BOTANY

See descriptions and course listings under Life Sciences, page 234.

BUSINESS

The Doctor of Philosophy in Business is awarded to those who complete the subject matter requirements listed below and the general requirements outlined in the first section of this catalog. The subject matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Those candidates who hold a master's degree in eco-

nomics or business can usually complete the requirements in two years by synchronization of courses previously taken with those offered in this program.

In lieu of the usual major and minor requirements for the doctorate, candidates for the Doctor of Philosophy in Business must prepare themselves for examination in five fields. Two of these, management and economic theory, are required, but the other three are elective. One of the elective fields may be outside the College of Commerce and Business Administration and must include at least two units. Within these requirements it is expected that each student will select, in consultation with his adviser, an individual program of study to meet his specific needs and objectives. For numbers and titles of courses available, see the listings in this catalog under accountancy, buisness education, economics, finance, industrial administration, and marketing.

Because the major fields for this degree cross departmental lines, administration of the work is supervised by a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the Chairman of the Committee on the Doctor of Philosophy Degree in Business, 360 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

499. Thesis Research. 0 to 4 units.

BUSINESS ADMINISTRATION

The Graduate School of Business Administration offers professional programs in business administration leading to the degrees of Master of Business Administration, Doctor of Business Administration, Master of Accounting Science, and Master of Commerce.

Master of Business Administration. The Master of Business Administration program is designed primarily for students whose undergraduate preparation is in liberal arts and sciences, engineering, or other nonbusiness areas. Students whose undergraduate preparation is in business may apply for admission, and the make-up of programs of those admitted is frequently adjusted to account for the special preparation of the degree candidate. The M.B.A. program requires a minimum of sixteen units (or sixty-four semester hours) of course work. No thesis is required. Candidates are admitted in September and February.

Doctor of Business Administration. Applicants for the Doctor of Business Administration program should have completed their master's program in the upper one-half of their master's class. A minimum of eight units of professional courses beyond the master's degree is required. Candidates who have earned a master's degree from one-year programs are required to complete a minimum of sixteen units of course work. Candidates are admitted in September, February, and June.

Master of Commerce. The Master of Commerce program is designed specifically for students whose undergraduate preparation is in business. Candidates for the Master of Commerce degree are required to take an evaluation examination upon entering the program. This examination covers the equivalent of the first-year M.B.A. program. An outstanding performance on this examination permits granting of the Master of Commerce degree after completion of eight units of course work. Normally, a candidate who is well prepared in the several areas of business administration is required to complete twelve to fourteen units of work.

Master of Accounting Science. For details of this program, see Accountancy, page 48.

Additional information concerning the requirements of the various degree programs may be obtained from the Graduate School of Business Administration, 260 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

500. **Business Economics.** Analysis of supply and demand functions in an uncertain environment; practical applications of economics to the management of business enterprise; the firm's place in the economic system; the place of the enterprise in national accounts. Case materials are used. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

501. **Managerial Economics.** Monetary and national income analyses essential to understanding governmental policies directed to macro-economic goals; the impact of such policies on the individual business firm and on decision-making by business management; the responsibilities of the individual business firms in contributing to the attainment of social goals of a macro-economic nature; the role of the business leader in formulating public policy in the macro-economic area. ¾ unit. Prerequisite: Business Administration 500 or equivalent.

510. **Administrative Behavior.** This course focuses on the problems faced by an administrator in an interpersonal setting. Primary emphasis is on the analysis of individual and group behavior in a union and nonunion work setting and the determination of actions which the administrator can take to promote desired work performance. Extensive use is made of theory and research related to individual and group behavior to aid in the diagnosis of problems covered. Students take part in either laboratory or field studies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

511. **Business Organization.** An analysis of business organization. Major emphasis is on the processes of allocation, coordination, and communication, making decisions about organizations under conditions of certainty and uncertainty for optimal performance, and measures of organizational performance. Critical examination of factors involved in choosing either a centralized or a decentralized style of organization. ¾ unit. Prerequisite: Business Administration 510.

512. **Business Organization and Its Environment.** An analysis of business organizations adapting to shifts in internal and external elements. Major emphasis is on (1) the business firm as a part of a complex socio-economic system; (2) the effects of government, labor unions, and political, religious, and business organizations on the executive's decision problems; (3) environmental factors conducive to organizational change; and (4) organizational growth. ¾ unit. Prerequisite: Business Administration 511.

513. **Seminar in Organization Theory.** This course examines the major types of organization theory. Use of organization theory to guide research and to make business decisions; examination of major research methods used to study business organizations. ¾ unit. Prerequisite: Business Administration 512.

520. **Marketing.** An introductory analysis of the marketing system, its operations, and the mechanisms for coordinating these operations. The relationships of the firm to other firms and other institutions in the marketing system are studied, and the effects that such relationships have on the nature of decision problems of the individual business are analyzed. The firm's problem in developing an integrated marketing program, and the specific problem areas of price, channel, location, sales, and market development are discussed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

522. **Quantitative Analysis for Marketing Decisions.** The development of analytic quantitative models of various aspects of the firm's marketing environment and of models of marketing decision problems is studied. The course also involves a study of the ways in which such models can be used as a basis for making marketing decisions. Topics include market measurement, estimation of various kinds of market data, identification of the relationships between marketing variables, and forecasting. ¾ unit. Prerequisite: Business Administration 520 or equivalent.

524. **Market Development.** Communication from manufacturers and middlemen to consumer and industrial users, and from manufacturers to middlemen, is an essential element in the marketing process. The course deals with management of the several components of the market communication function including personal selling, advertising, sales promotion, and some marketing aspects of public relations activities for both consumer and industrial goods. Management of the market communication function is studied through cases dealing with (1) determining market communications goals and policies; (2) creating an organization to perform the market communication function; (3) planning market communication operations, including problems such as planning a sales campaign, selecting advertising media, setting standards and coordinating advertising with personal selling, and dealer promotions; (4) stimulating personnel and controlling execution of the plans; and (5) evaluating results obtained from specific selling activities. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

525. **Product Management.** This course deals with the decisions on the firm's total market offer, including such topics as (1) use of market analysis in making decisions on assortment, product development, pricing, packaging, branding, and sales forecasting, and (2) coordination of these decisions and actions with market communications, physical movement, production, finance, and the over-all goals and policies of the firm. The use of analytic and research methods in making assortment and product decisions is emphasized. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

527. **Seminar in Marketing Theory and Policy.** This seminar is designed to study theories relating to the marketing system and the role of the individual business firm within that system. Marketing policy problems are discussed within the framework of various aspects of the firm's environmental circumstances. Marketing planning and decision-making processes covered include those involved in choice of policy concerning the marketing mix, price and product strategy, market development, and social and governmental relations. ¾ unit. Prerequisite: Business Administration 524 or 525.

531. **Introduction to Production.** An introductory course in decision-making problems in production. The course includes the theoretical foundations for production management as well as the applications of decision-making techniques to production problems in the firm. In particular, production processes, plant layout, maintenance, scheduling, quality control, and production control are considered. ¾ unit. Prerequisite: First semester of the M.B.A. program.

532. **Production Planning and Control.** Decision-making topics in production at the factory manager level and above are treated in depth. Topics include the development of generalized decision rules and systems analysis in production. In particular, the design of production control, quality control, and inventory control systems are stressed, and each of these systems is integrated into the firms as a whole. ¾ unit. Prerequisite: First year of the M.B.A. program.

533. **Quantitative Techniques in Production.** An advanced course in the application of quantitative techniques to decision-making problems dealing with production in the firm. Topics include structural estimation of production systems, application of operations research techniques to production problems, and computer simulation of decision systems. ¾ unit. Prerequisite: Business Administration 532 or equivalent.

540. **Written Analysis, I.** To develop the student's ability in writing reports based upon analysis of cases and the conclusions reached, this course has a threefold objective: (1) to improve the student's capacity to express himself effectively and efficiently in writing; (2) to contribute to the sharpening of his analytic skills; and (3) to help him integrate the knowledge learned in the functional fields. ½ unit. Prerequisite: Registration in the Graduate School of Business Administration.

541. **Written Analysis, II.** The first part of this course is devoted to the scientific method of inquiry and specific research techniques. The purpose is to study both elements of basic logic and research procedures in order to help the student evaluate the reliability of data and validity of conclusions contained in business reports. The second part of the course is devoted to a major field study. Each student develops a solution to a business problem and presents an oral and written report of the solution to both the faculty and the businessmen concerned. ½ unit. Prerequisite: Business Administration 540 or equivalent.

542. **Business and Society.** The position of the business enterprise as an institution in American society; the role of the businessman in that society. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

543. **Legal Problems of Business Management.** Past and current development of the legal climate in which business operates and in which managerial decisions are made; growth of the common law with its system of courts and procedure for law enforcement; the law of contracts, including various devices available for protection of creditors; legal problems involved in selecting a form of business organization. Students analyze business problems to see the importance of proper applications of the law to managerial decisions in regard to business policies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

544. **Executive Policies and Planning.** A course on policy construction at the executive level and the planning aspects of policy implementation. Builds a general management point of view. Study of company-wide situations from the vantage point of the chief executive. Case method study with supporting readings. Develops integration and application of the subject matter of prior courses. 1 unit. Prerequisite: Completion of first year of the M.B.A. program or equivalent.

545. **Business Logistics.** Movement, distribution, and control of raw materials and finished goods; site selection for manufacturing, warehousing, and distribution facilities; transportation media, selection, inventory control, communications networks, and requirements for logistics control data. Emphasis is on developing an integrated logistics system for a company. ¾ unit. Prerequisite: Enrollment in second year of the M.B.A. program or consent of instructor.

551. **Financial Analysis.** An introduction to the subject of managerial finance, with emphasis on basic decisions of management and provision of capital resources. Techniques of profit planning and forecasting, evaluation of financial performance relative to control standards, and development of criteria for commitment of funds are stressed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

552. **Financial Management and Control, I.** An analysis of the tools and techniques of capital expenditure management, with emphasis on the relation of financial forecasting and control to criteria for investment planning and asset management. The theory of investment is examined, as well as the relation of organizational structure to capital planning policy. ¾ unit. Prerequisite. Business Administration 551.

553. **Financial Management and Control, II.** An analysis of the problems confronting corporate financial management in deciding appropriate methods of financing capital expenditure commitments. A thorough analysis of the specialized literature, coupled with the use of selected case material, forms the core of the course. ¾ unit. Prerequisite: Business Administration 552.

554. **Financial Theory and Policy.** Special problems of economic analysis and their relation to the functional discipline of managerial finance; includes study of techniques for forecasting financial requirements under uncertainty, problems of income determination, the relation of long-term capital commitments to uncertain payoff vectors, internal and external capital rationing, and problems of identi-

fying capital supply functions. ¾ unit. Prerequisite: Business Administration 553, 573, and 576.

557. **Seminar in Finance.** Analysis of (1) financial policies and problems connected with corporate expansion through acquisition of interest in, or absorption of, established concerns, including an examination of the legal, economic, and financial background for business combination, or (2) specific problems of financial management in light of differing operating characteristics of major enterprise classifications, including opportunities for students to construct decision models for application to problems of financial management. ¾ unit. Prerequisite: Business Administration 554 and 573.

560. **Managerial Accounting and Control.** An analysis of managerial controls, the information needed for their operation, and the manner in which accounting provides that information; emphasis upon accounting as a tool of management. Problems and cases stress the type of figure information relevant to managerial decisions, and the methods of using such data. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

562. **Industrial Cost Control.** A study of cost accounting, with emphasis on the use of operating data by management for control purposes. Methods of material pricing, labor costs, including fringe benefits; indirect manufacturing costs, direct costing, standard costs; estimated and statistical costs; distribution costs; contribution to overhead theory; depreciation and replacement of equipment; selection of plant; decision to make or buy; relation between costs and pricing policy. ¾ unit. Prerequisite: Business Administration 560 or equivalent.

563. **Controllership.** The controller in the business organization: his property control responsibilities; internal check; internal audits; insurance; his assistance to operating management through budgeting, break-even analysis, profitability studies; his relationship with groups outside of management such as investors and government agencies; emphasis on manner in which figure function of controller is used to integrate the operations of the business enterprise. ¾ unit. Prerequisite: Business Administration 562 or equivalent.

570. **Mathematical Analysis for Business Decisions.** The use of classical mathematics in business decision-making; development of the concepts of total and marginal value analysis. Special emphasis is placed on the construction of quantitative models of business and economic systems, topics in bivariate and multivariate functions, differentiations, and integration. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

571. **Decision Theory.** Application of finite mathematics to business decision-making; an introduction to the theory of sets; partitions and counting; vectors and matrices, as well as Bayesian statistics. Major emphasis is placed on linear programming and the theory of games. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

572. **Modern and Classical Statistics for Business Decisions.** The application of classical and modern statistics for business decision-making; topics in probability distributions, variance analysis, and partial and multiple correlation analysis as well as the use of personal probabilities and utility theory. ¾ unit. Prerequisite: Business Administration 571.

573. **Introduction to Operations Research.** An introduction to operations research techniques; topics in integer, nonlinear, and dynamic programming, queueing theory, replacement, and Monte Carlo techniques; special projects in game theory applications in business. ¾ unit. Prerequisite: Business Administration 572; completion of first year of the M.B.A. program.

574. **Application of Operations Research Techniques.** The application of the operations research techniques developed in Business Administration 573 to practical

business problems. Most of the semester is devoted to a series of field research studies. Prior to the field studies, a review of previous work in the field is made. The role of the computer in solving operations research problems, as well as its application to the field research, is also a major consideration. ¾ unit. Prerequisite: Business Administration 573.

575. **Business Simulation.** An introduction to the use of computers in solving business problems. Topics include the relation of integrated data processing systems to information flows within the firm and the development of simulation models of intrafirm decision processes. ¾ unit. Prerequisite: Business Administration 573.

576. **Business Forecasting and Econometrics.** An introduction to maximum likelihood estimating techniques. Topics include the use and limitations of least squares, two-stage least squares, limited-information and full-information estimates. Problems with observational errors, multi-colinearity, and auto-correlation in time-series and cross-section structural estimation are considered. A major portion of the course is devoted to the application of the econometric techniques in business forecasting and analysis. ¾ unit. Prerequisite: Business Administration 572.

582. **International Business Operations, I.** An integration of economics and the functional areas of business focused on the problems of managing international business operations. Economic, legal, functional, and administrative problems are studied through cases and literature emphasizing financial and marketing problems. Students select one of Europe, Latin America, Africa, Middle and Near East, or South Asia and Far East, for special study and reporting. ¾ unit. Prerequisite: Completion of first year of the M.B.A. program.

583. **International Business Operations, II.** Continuation of Business Administration 582. ¾ unit. Prerequisite: Business Administration 582.

590. **Independent Study and Research.** Directed reading and research. ½ or 1 unit.

599. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

373. **Electronic Data Processing for Business.** A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general business is considered. The facilities of the Digital Computer Laboratory are utilized in the course. ½ or 1 unit. Prerequisite: Economics 170; Accountancy 106 or 108. HINOMOTO, WILL.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers work leading to the Master of Science and Doctor of Philosophy in Ceramics or in Ceramic Engineering. The prerequisite for graduate study in these areas is proficiency in the undergraduate courses required for the Bachelor of Science in Ceramic Engineering at the University of Illinois, or acceptable equivalents.

A minimum grade-point average of 3.75 for the last sixty hours of undergraduate work is required for admission. Students with grade-point averages between 3.75 and 4.0 are considered on an individual basis. Students who have bachelor's degrees in chemistry, physics, geology, or engineering may become candidates in this department, but they must make up deficiencies in ceramics.

A candidate for the Master of Science in Ceramics or Ceramic Engineering must complete a minimum of eight units of graduate work including a thesis.

Candidates for the Doctor of Philosophy in Ceramics or Ceramic Engineering are required to pass the departmental qualifying examination.

Candidates for the Doctor of Philosophy in Ceramics must present the equivalent of twenty-five semester hours of courses in inorganic, analytical, physical, and organic chemistry; calculus, including differential equations; one year of college physics; and a minimum of eighteen semester hours or equivalent in acceptable ceramics courses.

The most common minors selected by graduate students in ceramics or ceramic engineering are chemistry, physics, mathematics, geology, or other engineering disciplines.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramics prerequisite.

GRADUATE FACULTY

Professors: A. L. Friedberg (Head of Department), A. W. Allen, R. L. Cook, F. V. Tooley.

Associate Professors: C. G. Bergeron, J. A. Nelson, V. J. Tennery, T. A. Willmore.

Assistant Professor: G. S. Snow.

COURSES FOR GRADUATES

401. **Ceramic Chemistry.** Silica, silicates, fusions, and phase relations. 1 unit. Prerequisite: Courses in chemistry and physics.

402. **Ceramics.** Chemical and physical phenomena. 1 to 2 units. Prerequisite: Courses in physics and chemistry.

405. **Glass Technology.** This course, following a brief review of unit processes and operations in glass manufacture, treats from a dominantly theoretical and research point of view selected major topics relating to the glass preparation process and the chemical, mechanical, optical, and electrical properties of glass. ¾ unit. Prerequisite: Ceramic Engineering 301 or equivalent, or consent of instructor. Tooley.

406. **Glass Technology.** This course is dominantly theoretical in approach. Following a survey of the basic theoretical ideas that have been used in the development of the glass model, student readings and reports from the classical and modern literature serve as the basis of class discussions on glass structure and behavior, with emphasis on structure property correlations. ¾ unit. Prerequisite: Ceramic Engineering 405 or consent of instructor. Tooley.

407. **Porcelain Enamels.** This course covers the fundamental scientific principles involved in the area of porcelain enameling and the properties of such coatings. 1 or 1½ units (includes laboratory if taken for more than one unit). Prerequisite: Ceramic Engineering 222 and 320, or equivalent.

409. **Whitewares.** Advanced study in the field of whitewares, including fundamental considerations of glazes and all types of ceramic bodies. Special emphasis is placed on new developments in research and processing. Considerable attention is given to the ferroelectric and ferromagnetic properties of electronic ceramics. 1 or 1½ units (includes laboratory if taken for more than one unit). Prerequisite: Ceramic Engineering 309; Ceramic Engineering 340 or equivalent. Cook.

410. **Dielectric Properties of Ceramic Materials.** Fundamental properties of vector fields are reviewed. The reaction of insulating solids to external electric fields is considered in terms of dielectric theory. The properties of ceramic dielectrics including ferroelectrics are treated in terms of present theory. The piezoelectric properties of ferroelectric crystals and ceramics are correlated with the crystal structure, microstructure, and the ferroelectric properties. ¾ unit. Prerequisite: Mathematics 345 and 343, or consent of instructor. Tennery.

412. **Structural Physical Ceramics.** Structural chemistry and crystallization behavior of ceramic systems at elevated temperatures; nucleation, crystal growth; mineral synthesis; high-temperature reaction kinetics, including phase transformations and diffusion. ¾ unit. Snow.

414. **Physical Chemistry of Clays and Soils.** Same as Agronomy and Mining Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor.

421. **High-Temperature Technology.** A review of the methods of achieving and controlling high temperatures, both in industrial processes and in the laboratory, combined with a study of the techniques for measuring the properties of materials at elevated temperatures emphasizing oxides, carbon and graphite, silicates, carbides, borides, silicides, nitrides, sulfides, cermets, and refractory metals. A correlation of the physical and chemical behavior of these materials with their crystal structure, microstructure, and physical form is emphasized where possible. ¾ unit. Prerequisite: Ceramic Engineering 310. Allen.

422. **High-Temperature Technology Laboratory.** Laboratory to accompany Ceramic Engineering 421, with emphasis on instrumentation for and measurement of properties at elevated temperature. Analytical interpretation of data in numerical problems is included. ½ unit. Prerequisite: Credit or registration in Ceramic Engineering 421, or consent of instructor. Allen.

461. **Mineralogy of Clays.** Same as Geology 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. Grim.

462. **Mineralogy of Clays.** Same as Geology 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. Grim.

495. **Materials and Special Problems.** Conference and laboratory. 0 to 2 units.

499. **Thesis Research.** Research in any of the branches of ceramics. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Chemistry and Technology of Glass.** This course augments some of the subject matter of Ceramic Engineering 214, and develops additional subject matter relating to the theory of glass formation and structure and the behavior of glass as a function of composition, structure, and heat treatment. Students taking this course gain improved qualifications for research work in the field. ½ unit. Prerequisite: Ceramic Engineering 214 or consent of instructor. Tooley.

307. **Thermal and Mechanical Properties of Ceramic Materials.** Interpretations of the thermal and mechanical behavior of real ceramic materials utilizing the atomistic concepts of structure correlated with characterized microstructure. Half of the course treats the mechanism of thermal dilatation, heat transport and emission. The remainder integrates the characterization of deformation including elastic, anelastic, plastic, and viscous behavior. Temperature dependency is stressed throughout. Lectures and laboratory. ¾ unit. Prerequisite: Ceramic Engineering 216, 331, or equivalent; Theoretical and Applied Mechanics 154 and 221. Snow.

309. **Whiteware Materials.** A study of the characteristics and engineering properties of multi-phase polycrystalline aggregates and vitreous complexes including the raw material preparation, fabrication, and processing. Special emphasis is placed

on the single and multi-oxide component bodies, including the crystallographic structures of the alkaline earth titanates and the ferritic spinels as whiteware materials. ¾ unit. Prerequisite: Ceramic Engineering 216 or equivalent. Cook.

310. **Refractory Technology.** A study of the engineering properties and thermochemistry of polycrystalline materials for use at elevated temperatures, including processing of raw materials, the manufacture, heat treatment, quality control, and specification of refractory products. Particular emphasis is placed on oxides, silicates, carbides, borides, cermets, and refractory metals, with a correlation of the properties of those materials to certain design criteria. ¾ or 1 unit (includes laboratory if taken for one unit). Prerequisite: Ceramic Engineering 307. Allen.

311. **Ceramic X-Ray Analysis.** The use of x-ray diffraction for phase identification, for the determination of crystalline lattice parameters, and for the determination of the thermal expansion of crystalline solids is discussed; analytical methods of indexing powder diffraction patterns are covered; the determination of precise lattice parameters by means of computer programming and high temperature x-ray techniques is reviewed. ¾ unit. Prerequisite: Mathematics 195; senior standing in the departments of Engineering, Chemistry and Chemical Engineering, or Geology, or consent of instructor. Tennery.

320. **Advanced Porcelain Enamels.** An advanced study of the field of porcelain enamels with particular emphasis on fundamentals of bond or adherence of enamel metal systems, on opacity and mechanism of color development and measurement, and on the thermal and chemical properties of coatings on metal. Specific attention is given to coatings for use on metals at elevated temperatures. ½ unit. Prerequisite: Ceramic Engineering 222 or consent of instructor. Cook.

331. **Ceramic Microscopy.** A study of the optical activity in isotropic and anisotropic media with particular emphasis on the materials and products of ceramics; the application of these principles and related topics of optical microscopy to the study of the morphology, aggregation, size, and microstructure of the products of high-temperature thermochemical reactions and equilibria. ¾ or 1 unit (includes studies in thermal microscopy if taken for one unit). Prerequisite: Ceramic Engineering 205 and 216, or consent of instructor. Allen.

340. **Electrical Ceramics.** The subject of dielectric crystals and their electrical properties is presented; the ferroelectric and piezoelectric properties of several crystal classes are discussed and correlated; the perovskite class of ferroelectric compounds is covered in detail; spinel, garnet, and hexagonal type ferrimagnetic crystals and their properties are discussed. ¾ unit. Prerequisite: Ceramic Engineering 309 or consent of instructor. Tennery.

CHEMICAL PHYSICS

Fundamental research on many properties of molecular and solid state systems is based on an understanding of chemistry, physics, and mathematics that can best be obtained by training in more than one department of the University. A program leading to the Doctor of Philosophy in Chemical Physics makes it possible for students to gain the necessary background and perform original research in this interdisciplinary field of science.

Applicants for admission should have undergraduate degrees in chemistry or physics, a grade-point average of at least 4.0, and a strong background in the major field of chemistry or physics, with more than the usual training in the other area. Those who received their degrees in physics should have the equivalent of one semester each of organic and inorganic chemistry and one year of physical chemistry. Those who received their degrees in chemistry should have the equivalent of one semester each of

intermediate mechanics and intermediate electricty and magnetism. One year of mathematics beyond calculus is recommended. Deficiencies should be removed during the first year of study.

In addition to satisfying the requirements of the Graduate College, students must pass either the qualifying examination in the Department of Physics or the set of cumulative examinations given by the Division of Physical Chemistry. A knowledge of the content of Chemistry 348 and 349 or Physics 362 and 381 must be demonstrated also (for example, by passing the final examinations in these courses).

The program of graduate study consists of courses in the areas of mathematics, physics, and chemistry. A one-year course in quantum mechanics must be included, and the other courses must be selected from the three areas with the approval of the Committee on Chemical Physics.

Research for the dissertation is performed under the direction of staff members who are currently active in chemical physics. Students may apply for fellowships and assistantships and may make use of the facilities available in the Departments of Chemistry and Chemical Engineering and Physics.

Students with undergraduate degrees in chemistry should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering; students with undergraduate degrees in physics should direct inquiries and applications to the head of the Department of Physics.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering. Attention is also called to a joint program leading to the Doctor of Philosophy in Chemical Physics (see page 95) and to the program in Biophysical Chemistry (see pages 86, 97, and 241).

Students who have fulfilled the usual undergraduate course requirements, including at least twenty-five semester hours in chemistry properly distributed, and who have a grade-point average of 4.0 or above, may apply for admission to the Graduate College in chemistry or chemical engineering. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Students who have completed graduate work in chemistry or chemical engineering at another institution may be admitted if they have grade-point averages of 4.0 in both undergraduate and graduate work, or if they have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution.

Graduate students whose major subject in the Graduate College is in a department other than Chemistry and Chemical Engineering may take chemistry courses for graduate credit if they have had the equivalent of fifteen semester hours of chemistry. Such students are advised to consult members of the staff in choosing courses appropriate to their backgrounds and objectives.

MASTER OF SCIENCE IN THE TEACHING OF CHEMISTRY

Candidates for the Master of Science in the Teaching of Chemistry must earn four units in chemistry, two units in education, and two units of electives in either education or physical science. The two units in education consist of the following courses: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. The courses in chemistry and the electives, which must normally give graduate credit, must be selected with the approval of the adviser. Students applying for admission must have a grade-point average of at least 3.5. Inquiries concerning this program should be directed to Professor Don Secrest, 300a Noyes Laboratory.

CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engi-

neering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science must include two chemical engineering courses at the 400 level in their programs.

BIOCHEMISTRY

The Biochemistry Division of the Department of Chemistry and Chemical Engineering administers the graduate program in biochemistry. The curriculum is composed of Chemistry 350, 355, 450, 452, and 494 (same as Microbiology or Biophysical Chemistry 494), and selected offerings in allied chemical and biological areas. Interested students are invited to contact the biochemistry staff.

BIOPHYSICAL CHEMISTRY

The Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the student with basic training in physical chemistry, physical biochemistry, and biology. Students electing this area should have a solid background in physics and mathematics. Details of the curriculum are decided individually.

GRADUATE FACULTY

Professors: H. E. Carter (Head of Department), D. E. Applequist, J. C. Bailar, Jr., T. L. Brown, D. Y. Curtin, R. S. Drago, H. G. Drickamer, W. H. Flygare, I. C. Gunsalus, H. S. Gutowsky, L. P. Hager, G. P. Haight, Jr., T. J. Hanratty, H. A. Laitinen (Associate Head of Department), N. J. Leonard, H. V. Malmstadt, R. A. Marcus, J. C. Martin, T. Moeller, R. F. Nystrom, J. A. Quinn, K. L. Rinehart, H. R. Snyder, S. Swann, Jr., G. Weber, J. W. Westwater, P. E. Yankwich.

Associate Professors: P. Beak, R. L. Belford, J. M. Clark, A. M. Hartley, J. P. Hummel, R. S. Juvet, S. G. Smith.

Assistant Professors: J. E. Baldwin, J. K. Beattie, V. A. Bloomfield, R. M. Coates, H. E. Conrad, R. G. Denning, C. A. Eckert, J. Goodisman, J. L. Hudson, J. Jonas, I. C. Paul, W. H. Pirkle, R. L. Sani, R. A. Schmitz, G. J. Schroepfer, Jr., D. H. Secrest, G. D. Stucky, L. J. Todd, J. M. Wood, R. W. Woody.

Chemistry

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. 1 unit.

404. **Advanced Inorganic Chemistry Laboratory.** Specialized laboratory techniques; more difficult inorganic syntheses. ¼ to ¾ unit. Prerequisite: Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. ¼ unit.

406. **Physical Inorganic Chemistry.** Qualitative description of the bonding in inorganic compounds; use of physical methods to provide information about the structure and reactions of inorganic compounds; structures and reactions of inorganic compounds in solution. 1 unit. Prerequisite: Chemistry 315 and 344.

407. **Special Topics in Inorganic Chemistry.** Discussions of newly developing areas of inorganic chemical research. ¼ to 1 unit. Prerequisite: Graduate standing in chemistry. Kay.

408. **The Chemistry of Complex Inorganic Compounds.** The nature of the coordinate bond; applications of complex compounds. 1 unit. Prerequisite: Chemistry 315.

421. **Spectrochemical Methods of Analysis.** Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree.

422. **Electrical Methods of Chemical Analysis.** Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. 1 unit. Prerequisite: Chemistry 344 or equivalent.

423. **Electron Microscopy.** Same as Biology and Zoology 423. Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Open to qualified graduate students in any department. ¼ unit. Prerequisite: Adequate background in chemistry, physics, and mathematics; consent of instructor.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods. and applications. ½ unit.

425. **Analytical Chemistry.** Seminar. Required of all graduate students whose major is analytical chemistry. ¼ unit.

427. **Applied X-Rays: Crystallography.** Lectures. ¾ unit. Prerequisite: Training in physics and physical chemistry.

429. **Electron Microscopy Laboratory.** Same as Biology and Zoology 429. Essentially individual instruction. Detailed training in operation and care of electron microscopes (four types); preparation of specimens including microtomy, electron staining, replication, and shadow casting; measurements and interpretations; special projects related to student's research interests. Open to qualified graduate students in any department. ½ or ¾ unit. Prerequisite: Adequate background in chemistry, physics, and mathematics; credit or registration in Chemistry 423; consent of instructor.

430. **Organic Chemistry.** Survey of organic chemistry for graduate students. 1 unit. Prerequisite: One year of organic chemistry.

431. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on reaction mechanisms and synthesis. 1 unit. Prerequisite: Chemistry 430 or 336; one year of physical chemistry.

432. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on structure. 1 unit. Prerequisite: Chemistry 431 or 336.

433. **Organic Chemistry.** Special topics in organic chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as natural product synthesis and biosynthesis, organic photochemistry, chemistry of special families of organic compounds, etc. ½ or ¾ unit; ¾ unit requires two lectures per week. Students may repeat this course for credit. Prerequisite: Chemistry 431 and 432, one of which may be taken concurrently.

434. **Advanced Organic Synthesis.** Lecture and laboratory. ¼ to 1 unit.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. ½ unit. Prerequisite: Consent of instructor.

436. **Experimental Organic Chemistry.** A lecture course on research techniques in organic chemistry. ¼ unit. Prerequisite: Consent of instructor.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. 1 unit. Prerequisite: Consent of instructor.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and their molecular interpretation; determination and chemical use of thermodynamic quantities. 1 unit. Prerequisite: Chemistry 342 and 344, or equivalent.

442. **Statistical Thermodynamics.** Basic principles of classical and quantum statistics with applications to chemistry. 1 unit. Prerequisite: Chemistry 441 and 446, or consent of instructor.

445. **Physical Chemistry.** Seminar. Required of all graduate students whose major is physical chemistry. ¼ or ½ unit. Prerequisite: Consent of instructor.

446. **Quantum Chemistry, I.** An introduction to quantum mechanics: basic theory and methods of approximations; applications to atomic systems. 1 unit. Prerequisite: Chemistry 349 and Mathematics 388, or equivalent; consent of instructor.

447. **Quantum Chemistry, II.** Continuation of Chemistry 446. Application of quantum mechanics to chemical problems; theories of the chemical bond; structure and spectra of molecules. 1 unit. Prerequisite: Chemistry 446 or equivalent; consent of instructor.

448. **Chemical Kinetics.** Chemical reaction and the theory of rate processes. Lectures. ¾ unit. Prerequisite: Chemistry 441 or consent of instructor.

449. **Special Topics in Physical Chemistry.** An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. Students may register for credit more than once. ½ or 1 unit. Prerequisite: Consent of instructor.

450. **Chemistry of Biological Processes.** A consideration at the molecular level of biological processes including bioenergetics, biosynthetic and degradative pathways of cellular components, metabolic regulation and enzyme reaction mechanisms. 1 unit. Prerequisite: Chemistry 350 and 355.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. ¾ or 1 unit. Prerequisite: Chemistry 350 and 355.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. ½ unit. Prerequisite: Chemistry 350 and 355, or equivalent.

494. **Chemical Basis of Biological Specificity.** Biological formation and interaction of large molecules; analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles; nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; metabolic interrelations of these molecules. ¾ unit. Prerequisite: Chemistry 344, 346, and 350, or 450; Microbiology 330; or consent of instructor.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Animal Science 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

499. **Thesis Research.** A candidate for the master's degree who elects research is required to present a thesis. A thesis is always required of students working toward the Doctor of Philosophy. Not all candidates for thesis work necessarily are ac-

cepted. Any student whose major is in a department other than chemistry must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. Work may be taken in the following fields, subject to the approval of one of the qualified staff members:

Analytical Chemistry. Hartley, Jonas, Juvet, Laitinen, Malmstadt.

Biochemistry. Carter, Clark, Conrad, Gunsalus, Hager, Schroepfer, Spiegelman, Weber, Wood.

Biophysical Chemistry. Bloomfield, Paul, Weber, Woody.

Inorganic Chemistry. Bailar, Beattie, Brown, Denning, Drago, Haight, Moeller, Stucky, Todd.

Organic Chemistry. Applequist, Baldwin, Beak, Coates, Curtin, Leonard, Martin, Paul, Pirkle, Rinehart, Smith, Snyder.

Physical Chemistry and Chemical Physics. Belford, Bloomfield, Drickamer, Flygare, Goodisman, Gutowsky, Hummel, Jonas, Marcus, Paul, Secrest, Woody, Yankwich.

Chemistry:

Applied Electrochemistry—Organic and Inorganic. Swann.

Radiochemistry. Hummel, Nystrom.

Research for the Doctor of Philosophy is also offered in specialized fields other than those illustrated above. Students who intend to major in chemistry in one of these special fields should consult with the professor in charge of the thesis and with the head of the Department of Chemistry and Chemical Engineering in regard to the programs of courses and examinations.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and their compounds; types of bonding; survey of the periodic relationships; preparation and applications of the elements and their compounds. ¾ unit. Prerequisite: Credit or registration in physical chemistry.

316. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. ½ unit. Prerequisite: Credit or registration in Chemistry 315.

321. **Chemical and Instrumental Analysis.** Chemical and instrumental methods of analysis and their application to the quantitative study of chemical reactions. ¾ to 1¼ units. Prerequisite: Chemistry 336 and 340 or 342 with registration in Chemistry 343 and 344. Staff.

322. **Analytical Separations and Experimental Design.** Quantative study of separations by chemical and instrumental analytical methods. Application of statistics to separation methods, to experimental design, and to interpretation of experimental data. ¾ unit. Prerequisite: Chemistry 321 or equivalent.

323. **Electronics for Chemists.** Laboratory experimentation with basic instrument components, servo systems, operational amplifiers, digital circuits, and other circuits and devices used in modern instruments for scientific research. Discussions of basic principles and specific instruments. ½ unit. Prerequisite: Chemistry 321 or consent of instructor.

336. **Organic Chemistry.** Second course. Lectures and recitations. ¾ unit. Prerequisite: Chemistry 133 with a grade of A or B, or Chemistry 234.

337. **Organic Chemistry.** Laboratory experiments in organic chemistry. ½ unit. Prerequisite: Credit or registration in Chemistry 336.

338. **Systematic Identification of Organic Compounds.** 1 unit. Prerequisite: Chemistry 336 and 337, or equivalent.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. ¾ unit. Prerequisite: Chemistry 338 or consent of instructor.

340. **Principles of Physical Chemistry.** A one-semester course in physical chemistry emphasizing topics most important to students in the biological and agricultural sciences. Not open to students in the specialized curricula in chemistry or chemical engineering. 1 unit. Prerequisite: Physics 102; Chemistry 122 and 133, or equivalent; Mathematics 132 or equivalent.

341. **Elementary Physical Chemistry Laboratory.** A laboratory course to accompany Chemistry 340. ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a year-long study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. ¾ unit. Prerequisite: Chemistry 108, 122, 123, or equivalent; Physics 106, 107, and 108, or two semesters of general physics with concurrent registration in the third semester; credit or registration in Mathematics 142 or equivalent. STAFF.

343. **Physical Chemistry Laboratory.** Quantitative experimental study of chemical principles. Chemistry 343 and 345 constitute a year-long introduction to experimental physical chemistry. These courses may be taken consecutively or concurrently. ¼ unit. Prerequisite: Chemistry 342. STAFF.

344. **Physical Chemistry Laboratory.** Continuation of Chemistry 342. ¾ unit. Prerequisite: Chemistry 342. STAFF.

345. **Physical Chemistry.** Continuation of Chemistry 343. May be taken concurrently with Chemistry 343. ¼ unit. Prerequisite: Chemistry 342; credit or registration in Chemistry 343 and 344. STAFF.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins and high polymers; the use of physical methods for the characterization of such substances. ¾ or 1 unit (laboratory required for one unit). Prerequisite: Chemistry 340 or 344; consent of instructor.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. 1 unit. Prerequisite: Chemistry 344 or equivalent.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. 1 unit. Prerequisite: Chemistry 348.

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent.

351. **Metabolic Processes: Problems and Methods.** Laboratory experiments stress methods of conducting metabolic experiments with tissues, cells, cell components, and enzymes. Weekly discussions consider present concepts of the mechanism of chemical transport, hormone control, energy release, and of biosynthesis. ¾ unit. Prerequisite: Chemistry 350 and 355.

354. **Introduction to Biochemistry.** Lectures: Structure and function of living matter, with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. 1 unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor.

355. **Biochemistry Laboratory.** To accompany Chemistry 350. An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituent and transformations in biological systems. Laboratory, quizzes, and assigned readings. Required of all students who expect to take advanced courses in biochemistry. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; registration in Chemistry 350.

391. **Special Problems in Introductory Chemistry.** Designed to strengthen the chemical background of high school and junior college teachers and to integrate teaching of high school and college chemistry courses. Lectures, conferences, problems, and reports. Adaptable to individual needs. ½ or 1 unit. Prerequisite: Experience in teaching chemistry in high school or junior college.

392. **Applied X-Rays.** Generation and detection of x-rays, absorption and scattering of x-rays by matter; crystals, crystal and molecular symmetry; techniques of x-ray diffraction; identification and analyses; deduction of atomic positions. ¾ unit. Prerequisite: Chemistry 342 or consent of instructor.

393. **The Status of Modern Chemistry.** Lectures, demonstrations, discussions, and literature assignments in specialized areas of chemistry and chemical engineering, including analytical, inorganic, organic, and physical chemistry, biochemistry, and chemical engineering. Designed to broaden and strengthen the base of experience and knowledge of high school and junior college chemistry teachers. S; ¾ or 1 unit. Prerequisite: Experience in teaching chemistry in high school or junior college.

394. **Applied X-Ray Laboratory.** Techniques of x-ray analysis; powder techniques; fluorescence analysis; Weissenberg, precession camera techniques; reduction of film data; determination of crystal structure. ¼ to 1 unit. Prerequisite: Credit or registration in Chemistry 392, or consent of instructor.

395. **History of Science with Particular Reference to Chemistry.** ½ unit. Prerequisite: Twenty hours of laboratory science.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345. It is recommended that chemistry majors take Chemistry 344 before registering in this course; concurrent registration in Physics 385 is also recommended.

397. **Radiochemistry.** Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Nuclear Engineering 398. To accompany Chemistry 397. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. Laboratory and discussions. ½ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

Chemical Engineering

COURSES FOR GRADUATES

464. **Transport Phenomena.** Analysis of the various phenomena associated with transport processes; mechanism and phenomenological description; equations of change; interphase transport. Application to systems involving the transfer of energy, mass and momentum. 1 unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 373 or consent of instructor.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. ¼ unit. Prerequisite: Chemical Engineering 373.

466. **Applied Mathematics in Chemical Engineering.** The development of mathematical models and a survey of modern mathematical methods currently used in the solution of chemical engineering problems. Topics include the application of vectors and matrices, partial differential equations, numerical analysis, and methods of optimization in chemical engineering. ¾ or 1 unit. Prerequisite: Consent of instructor.

468. **Properties of Fluids.** The kinetic theory of gases and the prediction of transport coefficients; statistical mechanics applied to dense gases and liquids; theories of solutions. ¾ or 1 unit. Prerequisite: A background in modern physical chemistry and physics; consent of instructor.

469. **Special Topics in Chemical Engineering.** Various advanced topics are covered from time to time. These are generally taken during the second year of graduate study. Typical topics include turbulence, hydrodynamic instability, process dynamics, interfacial phenomena, reactor design, properties of matter at high pressure, phase transitions. ¾ or 1 unit. Prerequisite: Chemical Engineering 464

487. **Fluid Dynamics.** Basic concepts in fluid dynamics with special emphasis on topics of interest to chemical engineers. Derivation of the Navier-Stokes equations; solutions for creeping flow, for perfect fluids, and for boundary layers; non-Newtonian fluids; turbulence. 1 unit. Prerequisite: Chemical Engineering 464.

488. **Advanced Topics in Heat and Mass Transfer.** Principles of transfer operations developed in terms of physical rate processes. Boundary layer heat and mass transfer, eddy diffusion, phase changes, and separation processes. ¾ or 1 unit. Prerequisite: Chemical Engineering 464 or consent of instructor.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. Drickamer, Eckert, Hanratty, Hudson, Quinn, Sani, Schmitz, Swann, Westwater.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. Introduction to Process Engineering. Same as Food Science 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Prerequisite: Chemistry 340 or 342 or consent of instructor; one year of calculus.

367. Introduction to Process Control. An introduction to the control of industrial chemical processes. Lecture and laboratory. ¾ unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 371.

368. Chemical Engineering Kinetics. Principles of reaction kinetics and applications to reactor design. ¾ unit. Prerequisite: Chemical Engineering 370.

370. Chemical Engineering Thermodynamics. The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342.

371. Principles of Chemical Engineering. Introduction to fluid dynamics and heat transfer. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor.

373. Principles of Chemical Engineering. Introduction to mass transfer operations. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 371.

374. Unit Operations Laboratory. To accompany Chemical Engineering 373. Laboratory and computations in the unit operation. ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373.

377. Process Dynamics. The basic ideas of process dynamics and their applications in chemical engineering. ¾ unit. Prerequisite: Chemical Engineering 367 or consent of instructor.

379. Chemical Engineering Projects. Laboratory. Development of an individual project. ½ unit. Prerequisite: Senior standing in chemistry or chemical engineering.

380. Heat, Mass, and Momentum Transport. A unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. ¾ unit. Prerequisite: Mathematics 343 or 345; Chemical Engineering 371; or consent of instructor.

381. Chemical Engineering Plant Design. Comprehensive problems, lectures, and discussion on plant design and the economic factors involved in design and operation of chemical plants. ½ unit. Prerequisite: Chemical Engineering 373.

382. The Prediction of Physical Properties. The prediction of equilibrium and transport properties in gases, liquids, and solids. ½ unit. Prerequisite: One year of physical chemistry.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The Department of Civil Engineering offers a combination of advanced study and participation in creative research to meet the needs of individual students. Such graduate training prepares students to assume greater responsibilities and to contribute to the progress of the civil engineering profession. Graduate study and research can be pursued in the fields of air pollution; analysis and design of structures; behavior of structures and properties of structural materials (concrete, steel, and other materials); construction engineering and management; digital computer applications to analysis or design;

geodetic engineering; health physics; highway engineering; hydrology; hydromechanics and hydraulic structures; materials and structural design of roadways; models research; nuclear structural shielding; photogrammetry and photogrammetric engineering; radiological health; railway engineering; rock mechanics; soil mechanics and foundations; stream analysis; structural dynamics; design for earthquake, shock, and blast excitation; structural mechanics; systems analysis and design; traffic engineering; transportation planning; systems design and operations; urban planning and management; waste water treatment; water quality and treatment; and water resources.

The department is presently engaged in a substantial building program which will reach completion in several stages. The first phase houses the concrete structures, soil mechanics, and sanitary engineering groups. Later additions to the building will provide for others in the department's educational and research activities. These new laboratories have extensive facilities for the study of the fundamental behavior of structures and structural materials under static or dynamic, and repeated loads, and for the study of various environmental conditions found in the sanitary engineering and science fields.

The Master of Science and Doctor of Philosophy in Civil Engineering may be attained by qualified students who satisfy the requirements of the department and the Graduate College. Progress toward an advanced degree is measured not only by the accumulation of units of credit in formal course work but also by evidence of intellectual growth and achievement. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the Bachelor of Science in the branch of the subject in which registration is desired.

The Master of Science and Doctor of Philosophy are offered in Sanitary Engineering. The prerequisite for admission to the first year of graduate study is a Bachelor of Science in Engineering or in one of the physical or life sciences.

Admission to the Graduate College with full status in civil or sanitary engineering is granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois, provided the applicant's preparation is appropriate to advanced study in his chosen major field and his scholastic average is at least 4.0. Under certain conditions, applicants with a grade-point average of less than 4.0, and applicants from schools with different grading systems, may be considered if their average is equivalent to or higher than 3.75 and evidence is submitted indicating that the applicant's ability is not appropriately measured by the grades submitted.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor must be approved by the head of the department.

A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units are required.

A pamphlet entitled *Graduate Study and Research in Civil and Sanitary Engineering* is available upon request to the Head, Department of Civil Engineering.

GRADUATE FACULTY

Professors: N. M. Newmark (Head of Department), W. C. Ackermann, A. H-S. Ang, J. E. Baerwald, J. W. Briscoe, A. B. Chilton, V. T. Chow, E. Danner, D. U. Deere, R. S. Englebrecht, R. A. Eubanks, B. B. Ewing, S. J. Fenves, E. H. Gaylord, W. J. Hall, J. D. Haltiwanger (Associate Head of Department), W. W. Hay, M. Herrin, H. O. Ireland, H. M. Karara, C. E. Kesler, N. Khachaturian, T. E. Larson, M. B. McPherson, J. L. Merritt, Jr., W. H. Munse, J. P. Murtha, R. E. Olson, J. E. Pearson, R. B. Peck, A. R. Robinson, M. O. Schmidt, L. R. Shaffer, C. P. Siess, G. K. Sinnamon, M. A. Sozen, J. E. Stallmeyer, T. H. Thornburn.

Associate Professors: J. H. Austin, M. T. Davisson, G. Gracie, H. K. Hilsdorf, H. M. Horn, T. K. Liu, V. J. McDonald, R. J. Mosborg (Assistant Head of Department), N. N. Nielsen, J. T. O'Connor, A. F. Richards, W. C. Schnobrich, R. N. Wright.

Assistant Professors: E. J. Barenberg, D. M. Brown, R. I. Dick, G. C. Feng, W. L. Gamble, A. J. Hendron, E. R. Holley, Jr., W. H. C. Maxwell, J. W. Melin, S. L. Paul, J. B. Radziminski, H. J. Rainer, M. R. Thompson, C. C. Tung, W. H. Walker, H. G. Wenzel, Jr.

COURSES FOR GRADUATES

401. **Geodetic Engineering.** Elements of geodesy; principles and practice of precise triangulation, traverse, and levels. 1 unit. Prerequisite: Bachelor of Science in civil engineering. Schmidt.

403. **Photogrammetry.** Study of the principles of stereoscopy and geometrical optics; aerial cameras, their design and calibration; the design, construction, and operation of stereoscopic plotting machines; mathematics of stereoscopic orientation and model deformations. 1 unit. Prerequisite: Civil Engineering 302 or consent of instructor. Karara.

404. **Photogrammetry.** Theory of errors of stereoscopic photogrammetry; aerotriangulation (spatial and radial), its theory and applications to various civil engineering problems; electronics in photogrammetry; practice in compiling maps from aerial and terrestrial photographs. 1 unit. Prerequisite: Civil Engineering 302 or consent of instructor. Karara.

416. **Design of Construction and Industrial Operations, I.** Same as Industrial Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor. Shaffer.

417. **Design of Construction and Industrial Operations, II.** Same as Industrial Engineering 417. Continuation of Civil Engineering 416. 1 unit. Prerequisite: Civil Engineering or Industrial Engineering 416; credit or registration in Mathematics 315; or consent of instructor. Shaffer.

420. **Pavement Design, I.** Analysis and methods of measurement of surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper surface properties, load carrying capacity, wear resistance, stability, and durability. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. Danner.

421. **Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. Herrin.

422. **Fundamental Properties and Behavior of Bituminous Mixtures.** Composition and theories of physical structure of bitumens; rheological, failure, durability, and adhesive properties of bitumens and bituminous mixtures; analysis of factors influencing the performance of bituminous aggregate mixtures. 1 unit. Prerequisite: Civil Engineering 321 or consent of instructor. Herrin.

423. **Highway Materials Stabilization.** Stabilization of aggregates and soils with cement, lime, bituminous materials, and other stabilizing agents; basic stabiliza-

tion reactions, properties of stabilized materials, and composition design are emphasized. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor. THOMPSON.

426. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. 1 unit. Prerequisite: Civil Engineering 325 or equivalent. BAERWALD.

427. **Geometric Highway Design.** Highway classification; highway capacity; highway design controls; sight distance; horizontal and vertical alignment; cross section elements; highway types; controlled access highways; design of at-grade of intersections, grade separations, and interchanges. 1 unit. Prerequisite: Civil Engineering 325 and 426, or consent of instructor. BAERWALD.

428. **Traffic Engineering Operations.** Theory of traffic control; laws and ordinances; design and application of traffic control devices; special street designations; parking design and control; street illumination; miscellaneous traffic control designs. 1 unit. Prerequisite: Civil Engineering 325 and 426, or equivalent. BAERWALD.

435. **Railway Construction and Maintenance.** Roadbed load capacity; economic design of track; advanced geometric design; economics of maintenance; grade crossing separations; review of specific projects. 1 unit. Prerequisite: Civil Engineering 335. HAY.

436. **Railroad Location and Operation.** Track and traffic capacity; optimum train size, performance, and scheduling; validity and accuracy of current practices; regional operating factors; optimum size of plant and modern location. 1 unit. Prerequisite: Civil Engineering 336 or consent of instructor. HAY.

440. **Theory of Water Treatment.** Properties of water and criteria of water quality; gas transfer operations in water treatment; chemical treatment processes; corrosion and corrosion control; sedimentation; filtration; disinfection; control of aquatic growths; control of tastes and odors. 1 unit. Prerequisite: Chemistry 122 and Microbiology 101. DICK, O'CONNOR.

441. **Analysis and Treatment of Water and Waste Water.** Physical, biological, and chemical analysis of water and waste water; field sampling techniques; removal of objectionable impurities, principles of disinfection; determination of dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand; nitrogen, sulfur, and phosphorous compounds in waste waters. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440. AUSTIN, O'CONNOR.

442. **Theory of Waste-Water Treatment.** Composition, properties, and analysis of wastes; microbiology of waste treatment; pollution of natural waters; sedimentation; chemical treatment; aerobic and anaerobic treatment processes; disposal of waste sludges. 1 unit. Prerequisite: Civil Engineering 346; Chemistry 122; Microbiology 101. AUSTIN, ENGELBRECHT.

443. **Advanced Sanitary Engineering Laboratory.** Experimental and pilot plant studies of the operational characteristics for various physical, chemical, and biological unit operations and processes used in the treatment of water and waste water. 1 unit. Prerequisite: Civil Engineering 441; credit or registration in Civil Engineering 442. DICK, O'CONNOR.

444. **Industrial Water and Wastes Treatment.** The theory and application of unit operations unique to the treatment of industrial water and wastes; advanced consideration of industrial waste problems of major industries; techniques of saline water conversions. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440 and 442, or consent of instructor. ENGELBRECHT, O'CONNOR.

445. **Water Quality and Pollution.** Water quality standards and criteria for various beneficial uses; transport mechanisms for pollution in surface streams and ground

water; fate of pollution and pollution control. 1 unit. Prerequisite: Civil Engineering 250 and 251; Mathematics 345. DICK, EWING.

446. **Design of Water and Waste Treatment Plants.** A study of the fundamental factors affecting choice of treatment units and combination of unit processes into an integrated plant. 1 unit. Prerequisite: Civil Engineering 440, credit or registration in Civil Engineering 442, or consent of instructor. DICK, EWING.

447. **Radioactive Waste Disposal.** Same as Nuclear Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous wastes disposal; air-monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282, or Chemistry or Nuclear Engineering 398, or consent of instructor. AUSTIN, EWING.

448. **Control of Air Pollution.** A study of air contaminants from all types of sources; deleterious effects of contaminants on plants, animals, and materials; determination of source strength; basic theory of control devices; air pollution surveys; and organization of control programs. 1 unit. Prerequisite: General Engineering 360. AUSTIN, PEARSON.

449. **Analysis of Air Pollutants.** Laboratory analysis of common air pollutants; theory of operation of laboratory and automatic field instrumentation. ½ or 1 unit. Prerequisite: Credit or registration in Civil Engineering 448. AUSTIN, PEARSON.

450. **Advanced Hydrologic Analysis and Design.** Hydrologic cycle; hydrometeorology; collection of data; hyetograph and hydrograph analyses; infiltration and evapotranspiration studies; groundwater exploration and recharge; statistical analyses; determination of waterway areas; flood routings; river and reservoir regulations; design and planning of flood control projects; and modern development such as radar weather, radioactive tracers, disposal of nuclear wastes, and electronic analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW.

452. **Water Resources.** An advanced interdisciplinary course on water resources planning and development; geographic aspects; data collection; governmental functions; hydrologic implications; river hydraulics; hydraulic physical units and water quality; economic aspects; legal, political, and social problems; case studies. 1 unit. Prerequisite: Consent of instructor. CHOW, STAFF.

456. **Hydraulics of Surface Drainage.** Applications of hydraulics and hydrologic principles; elements of channel design, hydrologic determination of design flow, hydraulics of culverts and bridge openings, overland flow, flow in gutters and inlets, and hydrologic and hydraulic design of a bridge opening or culvert system. 1 unit. Prerequisite: Theoretical and Applied Mechanics 235. STAFF.

457. **Ground Water.** An advanced interdisciplinary course on ground water; hydrogeology; hydrodynamics of flow through porous media; ground water hydrology; hydraulics of wells; hydraulic analysis of seepage; ground water pollution; ground water resources. 1 unit. Prerequisite: Consent of instructor. CHOW, STAFF.

458. **Open-Channel Hydraulics.** Basic hydromechanics; flow types; channel characteristics; flow-profile computations; hydraulic jump analysis; design of nonerodible, erodible, and grassed channels and transitional structures; study of supercritical flow and unsteady flow; modern developments in theory and design practice; application of numerical method, method of characteristics, method of singular point, and electronic digital computers and analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW.

460. **Structural Analysis.** Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quanti-

tative influence lines. 1 unit. Prerequisite: Bachelor of Science in engineering with a course in theory of simple structures. GAYLORD, HALTIWANGER.

461. **Structural Theory and Design.** Advanced structural theory from the standpoint of design, analysis, and behavior, with particular emphasis on analysis; evaluation of methods of elastic analysis of structures; limit design and analysis; continuous beams and frames; multiple-story structures; space frames; arches. 1 unit. Prerequisite: Bachelor of Science in civil engineering; Civil Engineering 361 or 460, or equivalent. FENVES, HALL, STALLMEYER.

462. **Structural Theory and Design.** Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long span roofs. 1 unit. Prerequisite: Bachelor of Science in civil engineering; Civil Engineering 361 or 460, or equivalent. MOSBORG, STALLMEYER.

463. **Optimization of Structures.** Structural design processes; formulation of problems in the optimization of structures; optimization of structural elements; minimum volume principles; use of mathematical programming in optimization of structural systems. 1 unit. Prerequisite: Consent of instructor.

465. **Structural Design in Metals.** Theories of behavior of structural metal members and their components; interpretation of codes and specifications for the design of bridges and buildings. This course and Civil Engineering 475 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequsitie: Bachelor of Science in engineering with courses in structures. GAYLORD.

467. **Behavior of Reinforced Concrete Structures.** Ultimate strength and behavior of statically indeterminate reinforced concrete structures; applicability of elastic analysis to framed structures; analysis and design of floor slabs in buildings. 1 unit. Prerequisite: Civil Engineering 366. SIESS.

470. **Statistical Theory of Structural Engineering.** Study of the concepts and applications of probability and statistical theory in structural engineering and research, with emphasis on the scientific principles for considering fluctuations and randomness in physical phenomena and processes; mathematical modeling in structural mechanics including Monte Carlo simulation in structural systems analysis and design; engineering decision-making under uncertainty; analysis of loads and resistances; safety analysis of structures including system reliability prediction; introduction to stochastic structural dynamics. 1 unit. Prerequisite: Consent of instructor. ANG.

471. **Numerical and Approximate Methods of Structural Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments, and deflections of plates, other problems. 1 to 2 units. EUBANKS, MELIN, ROBINSON.

472. **Advanced Numerical Methods in Engineering.** Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures; blast, impact, and earthquake effects on structures; buckling and flexure of frameworks; torsion of solid and thin-walled sections; lateral buckling of beams; bending and buckling of plates and of stiffened plates; plane stress and axially symmetric problems in elasticity; other topics. 1 to 2 units. Prerequisite: Civil Engineering 471. EUBANKS, ROBINSON.

473. **Analysis and Design of Plates and Shells.** Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of re-

inforced concrete bridge and building floors, highways and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs, and hipped plate construction. 1 to 2 units. Prerequsite: Consent of instructor. SCHNOBRICH.

474. **Behavior of Structures Under Dynamic Loads.** Free vibrations, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analytical methods for the effects of wind load, explosion blast, impact, earth tremors, and other time-dependent excitations; effects of damping and inelastic action; propagation of stress waves; wind-induced vibrations with application to cables, pipelines, and tall stacks. 1 to 2 units. Prerequisite: Consent of instructor. WALKER.

475. **Behavior of Steel Structures.** A critical evaluation of the actual behavior of metals, connections, members, and structures; the significance of this behavior in terms of design and the development of design specifications. This course and Civil Engineering 465 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Graduate standing in civil engineering or theoretical and applied mechanics. MUNSE.

476. **Plastic Analysis and Design.** Inelastic behavior of metal structural frameworks; concept of the plastic hinge; collapse configurations; analysis of collapse mechanisms; requirements for stability; deflections, incremental collapse, shakedown; connections; optimum design; grid frameworks. 1 unit. Prerequisite: Civil Engineering 465 or consent of instructor. GAYLORD.

477. **Design of Structures for Dynamic Loads.** Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast-resistant structures; criteria for design of earthquake-resistant structures; application to actual problems. 1 unit. Prerequisite: Consent of instructor. HALTIWANGER.

478. **Matrix Theory of Structural Mechanics.** Fundamental concepts of matrix calculus and its applications for a unified treatment of advanced structural mechanics and dynamics; basic calculus of matrices; iterative solution of systems of algebraic and differential equations; stress and structural analysis, method of tearing tensors; discrete simulation of continuous systems in higher dimensions; eigenvalue problems of discrete systems. 1 unit. Prerequisite: Civil Engineering 461 or 471, or consent of instructor. ANG.

479. **Applied Structural Mechanics.** Study of beams under lateral load; beams with combined lateral load and thrust; buckling; beams on elastic foundations; applications of Fourier series and virtual work principles to beam-type structures; stress and strain in three dimensions; applications to flexure of beams and plates and to constrained torsion; elements of the engineering theory of plates. 1 unit. Prerequisite: Mathematics 345 and one undergraduate course in statically indeterminate structures, or consent of instructor. PAUL, ROBINSON.

480. **Earth Pressures and Retaining Structures.** Classical and modern earth pressure theories and their experimental justification; pressures and bases for design of retaining walls, bracing of open cuts, anchored bulkheads, cofferdams, tunnels, and culverts. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384. HORN, IRELAND, PECK.

481. **Earth Dams and Related Problems.** Fundamentals of problems of slope stability; seepage in composite sections and anisotropic materials; methods of stability analysis; mechanism of failure of natural and artificial slopes; compaction; field observations. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384, or consent of instructor. PECK.

482. **Measurement of Soil Properties.** Laboratory and field work in soil sampling, classification, and testing; experimental studies of modern soil mechanics parameters and theories with emphasis on applications to design problems. Experiments include permeability, consolidation, direct shear, and triaxial shear. The research approach is used to point out interpretations and limitations of data in practice. 1 unit. Prerequisite: Credit or registration in Civil Engineering 383, or consent of instructor. Olson.

483. **Soil Mechanics.** Advanced studies of research techniques in soil mechanics and foundation engineering. 1 unit. Prerequisite: Civil Engineering 384 or consent of instructor. Olson.

484. **Foundation Engineering.** Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. 1 unit. Prerequisite: Civil Engineering 384. Ireland, Peck.

485. **Soil Engineering for Transportation Facilities.** Problems of soil classification; evaluation of stability of natural and compacted soils as subgrades, slopes, and embankments; effect of climate, soil properties, compaction, and admixtures on subgrade stability. 1 unit. Prerequisite: Civil Engineering 383 or equivalent. Liu, Thornburn.

492. **Measurement Theory and Experimental Design.** The principles of engineering experimentation from both a classical and a statistical point of view. Nature of experimental error; test planning; data analysis; special techniques. Examples within the civil engineering discipline are emphasized. 1 unit. Prerequisite: Mathematics 263 or equivalent. Chilton.

494. **Municipal Administration and Engineering.** Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning; building codes and inspection; street lighting; public utilities; city cleaning; recreational development. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. Danner.

495. **Civil and Sanitary Engineering Seminar.** Discussion of current topics in civil and sanitary engineering and related fields by staff, students, and visiting lecturers. Course may be repeated. 0 or ¼ unit.

497. **Special Problems.** Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the investigation. 0 to 4 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Surveying.** Precise horizontal and vertical control surveys; state plane coordinate systems; special construction surveys. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

302. **Photogrammetric Engineering.** A study of metrical photography in civil engineering practice; characteristics and interpretation of aerial and terrestrial photographs; stereoscopic compilation of maps from photographs; mosaics; economics of photogrammetry; map reproduction. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

305. **Observational Astronomy.** Same as Astronomy 314. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors;

theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210; Mathematics 142 or 143.

314. **Fundamentals of Systems Approach.** Introduction to the application of linear programming, network theory, and queueing theory to the synthesis of civil engineering systems. ½ or 1 unit. Prerequisite: Civil Engineering 215; Mathematics 263 or consent of instructor.

315. **Construction Productivity.** Introduction to the application of scientific principles to the measurement of and the forecasting of productivity in construction engineering; conceptual and mathematical formulations of the labor, equipment, and material factors affecting productivity. ½ or 1 unit. Prerequisite: Civil Engineering 215; credit or registration in Mathematics 263 or equivalent; or consent of instructor.

316. **Construction Planning.** Introduction to the application of scientific principles to the normative planning of construction operations. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

318. **Construction Cost Analyses and Estimates.** Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts of and statistical measurements of the factors involved in direct costs, general overhead costs, cost mark-ups and profits; the fundamentals of cost recording for construction cost accounts and cost controls. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

321. **Bituminous Materials and Mix Design.** Properties and control testing of bituminous materials; analysis of bituminous paving mixtures; composition and design of asphaltic concrete and soil-asphalt mixes. ½ unit. Prerequisite: Civil Engineering 214 and 220, or consent of instructor.

322. **Development of Highway Facilities.** Analysis of factors in developing a highway transportation facility; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; highway maintenance planning. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

325. **Highway Traffic Characteristics.** Vehicle operating characteristics; driver characteristics; pedestrian characterestics; roadway characteristics as they individually and collectively as traffic stream characteristics are related to the planning, design, and operation of highway facilities. ½ unit. Prerequisite: Civil Engineering 220 or consent of instructor.

333. **Urban and Regional Transportation.** Importance of transportation and its relation to urban and regional planning; characteristics of transport systems; transportation planning including surveys, data analysis, and problems of administration and finance; coordination and integration of transport. ½ or 1 unit. Prerequisite: Consent of instructor.

334. **Airport Design.** Basic principles of site selection for airports and fundamental considerations of design, construction, and maintenance of airport pavements and structures. ½ or 1 unit. Prerequisite: Civil Engineering 220 and senior standing in civil engineering, or consent of instructor.

335. **Railway Construction and Maintenance.** Loads and load distribution on track and subgrade; roadbed construction and stabilization; track stresses, design, and materials; turnouts and crossings; maintenance programs. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

336. **Railway Location and Operation.** Influence of traffic, alignment, distance, gradients, and motive power upon operating expenses; mechanics of train operation; economic design of location. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

337. **Signals.** Train movements; systems of signals; track circuits; track capacity; interlockings; economics of signaling. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

338. **Terminals.** Design and operation of freight terminal facilities for rail, highway, air, and water carriers; passenger terminals; special terminal requirements for specific commodity categories; coordination. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

345. **Environmental Health Engineering.** The application of engineering principles to the control of environmental sanitation and communicable disease control, including administration, biostatistics, epidemiology, vector control, pesticides, milk and food sanitation, swimming pools, individual water supply and wastewater disposal, plumbing, refuse collection and disposal, industrial hygiene and air pollution, radiological health and international health. ¾ unit. Prerequisite: Consent of instructor.

346. **Biology of Polluted Water.** The significance of biology in water quality, stream pollution, and waste treatment. ½ unit. Prerequisite: Consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Nuclear Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry: sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

351. **Hydromechanics.** Applied fluid mechanics with particular reference to topics in hydraulic design, analysis, and research in civil engineering areas; covers dimensional analysis and dynamic similarity, analysis of potential flow, boundary-layer problems, turbulence, and diffusion; hydraulic transients, water waves, transport phenomena. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 251.

352. **Water Resources Design.** Study and evaluation of phases of river mechanics; water resources history and project implementation; development of a water resources project plan. ¾ unit. Prerequisite: Civil Engineering 250; Theoretical and Applied Mechanics 235.

353. **Hydraulic Structures.** Introduction to the design of hydraulic structures, including consideration of types and function of dams; hydrologic design; hydraulic design of spillways and outlet works; determination of loads and stresses for concrete structures; seepage, piping, and stability of earth structures. ¾ unit. Prerequisite: Civil Engineering 250 and 251.

354. **Hydraulic Engineering Laboratory.** Fundamental principles, operation, and use of model laboratories; dimensional analysis; hydraulic similitude; theory and design of hydraulic models as applied to a specific laboratory problem. ¾ unit. Prerequisite; Theoretical and Applied Mechanics 235.

361. **Advanced Structural Analysis.** Numerical methods of structural analysis; general theory of continuity; prismatic and nonprismatic members; continuous framed structures; trussed structures; lateral load distribution; secondary stresses. ¾ or 1 unit. Prerequisite: Civil Engineering 262 or equivalent.

363. **Behavior and Design of Metal Structures, II.** Members under combined loads; welded, riveted, and bolted connections; moment-resistance connections; plastic design. ¾ or 1 unit. Prerequisite: Civil Engineering 263 or consent of instructor.

364. **Reinforced Concrete Design, II.** Limit design of continuous reinforced concrete members and slabs of various types. ¾ or 1 unit. Prerequisite: Civil Engineering 264; credit or registration in Civil Engineering 262.

366. **Behavior of Reinforced Concrete Members.** Ultimate strength and behavior of reinforced concrete members and relation between results of research and current specifications for design; members subjected to flexure, axial compression, combined flexure and axial load, combined flexure and shear, and bond. 1 unit. Prerequisite: Bachelor of Science in civil engineering or architecture with courses in structures and reinforced concrete design.

368. **Prestressed Concrete.** Principles and methods of linear prestressing; behavior, strength, and design of noncomposite simple beams, composite simple beams, and continuous beams; time-dependent variables and long-time deflections. ¾ or 1 unit. Prerequisite: Civil Engineering 262 and 264.

369. **Behavior and Design of Wood Structures.** Theory and practice in design of modern wood structures; effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. ¾ or 1 unit. Prerequisite: Civil Engineering 261 or equivalent, or consent of instructor.

380. **Foundation Engineering.** Evaluation of subsoil conditions as they affect the behavior, proportions, and choice of type of foundations; bearing capacity and settlement analyses; character of natural soil deposits; earth pressure theories and retaining wall analysis; slope stability. 1 unit. Prerequisite: Civil Engineering 210.

383. **Soil Mechanics.** Identification, description, and classification of soils; index properties, weight-volume relationships; hydraulic properties; stress-deformation characteristics; ultimate strength; subsurface exploration; character of natural soil deposits. ¾ or 1 unit. Prerequisite: Consent of instructor.

384. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; earth pressure and retaining walls; braced cuts; damage due to construction operations. ¾ or 1 unit. Prerequisite: Civil Engineering 383 or consent of instructor.

385. **Engineering Aspects of Surficial Soils.** Use of geologic and pedologic information and airphoto interpretation techniques in the prediction of engineering properties of soils and the planning of engineering soil surveys. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Civil Engineering 210 or consent of instructor.

391. **Computer Methods in Civil Engineering.** Review of programming concepts; formulation and programming of numerical, data-processing, and logical problems with applications to various branches of civil engineering; organization of programs and data; development and use of problem-oriented programming languages in civil engineering. ½ or 1 unit. Additional work required for more than ½ unit of credit. Prerequisite: Mathematics 195 or equivalent; senior or graduate standing in the Department of Civil Engineering or consent of instructor.

THE CLASSICS

(Including Classical Civilization, Greek, and Latin)

The Department of Classics offers graduate work leading to the Master of Arts and Doctor of Philosophy.

The Master of Arts may be taken in Latin, in Greek, in the Classics, or in the

Teaching of Latin. For the Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. No master's thesis is required; extra units of work in Greek or Latin are substituted for the thesis.

The Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All graduate students should take Greek or Latin 495-496, Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a departmental brochure which may be obtained by applying to the head of the department, 360 Lincoln Hall.

At the beginning of each term, written examinations in the translation of Greek and Latin are scheduled. Candidates for the master's degree (or equivalent) must take one examination in their major language each term. Advanced students must take both the Greek and Latin examinations each term until the preliminary examination has been passed. Satisfactory performance in both languages is required before admission to the preliminary examination.

GRADUATE FACULTY

Professors: J. L. Heller, R. P. Oliver, A. Turyn.

Associate Professors: J. J. Bateman (Head of Department), M. Naoumides.

Assistant Professor: M. R. Dilts.

Classical Civilization

The following courses presuppose no knowledge of the Greek or Latin language and are open to all students. For other courses in the area of classical civilization, see Art 305, 306, and 307; History 381, 382, 383, and 384; and Philosophy 303 and 309.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Classical Literary Traditions, I.** Greek literature from Homer to Aristotle. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Naoumides.

302. **Classical Literary Traditions, II.** Literary forms in the Alexandrian and Roman periods. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Bateman.

318. **Elements of Technical Terminology.** Presentation and analysis of Greek and Latin prefixes, suffixes, and root-words basic in the vocabularies of modern science, especially botany, psychology, zoology, and medicine. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent, or completion of twenty hours of science or architecture. Heller.

361. **The Archaeology of Greece.** Monuments and material remains illustrating the development of Greek civilization to 323 B.C. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor.

362. **The Archaeology of Italy.** Monuments and material remains illustrating the development of Graeco-Roman and other ancient Italian civilizations to 330 A.D. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 361 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. **Greek Versification.** Greek prosody: survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. 1 unit. Turyn.

411. **Hellenistic Literature.** 1 unit. Bateman.

412. **Lucian and His Age.** 1 unit.

413. **Greek Lyric Poetry.** 1 unit. Turyn.

414. **Pindar.** 1 unit. Turyn.

415. **Homer.** 1 unit. Bateman.

416. **Thucydides.** 1 unit. Naoumides.

417. **Bacchylides.** 1 unit. Naoumides.

422. **Sophocles.** 1 unit. Turyn.

423. **Aeschylus.** 1 unit. Turyn.

424. **Euripides.** 1 unit. Turyn.

425. **Greek Drama: Comedy.** 1 unit. Turyn.

491. **Directed Reading.** ½ unit. Prerequisite: Second-year graduate standing.

495. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. ½ unit. Oliver.

496. **Bibliography and Criticism.** Same as Latin 496. ½ unit. Oliver.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. Bateman, Heller, Naoumides, Oliver, Turyn.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Comparative Grammar of Greek and Latin.** Same as Latin and Linguistics 308. A historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

391. **Readings in Greek Literature.** Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. ¾ unit. Prerequisite: Two years of college Greek; consent of instructor. Staff.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of

French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. Three of the four required units in Latin must be in courses numbered above 400; the other unit is from Latin 311, 312, or 391. The required work in education consists of Educational Psychology 311 and 312 and one unit selected from History and Philosophy of Education 303, 304, 305. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. J. Bateman, 361 Lincoln Hall. See pages 41 and 42.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 360 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is four years of college Latin or equivalent.

401. **Readings in Latin for Graduate Students.** Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. No graduate credit. Prerequisite: Two years of high school Latin or equivalent.

409. **History of the Latin Language.** 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language.

410. **Vulgar Latin.** 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language.

411. **Latin Epigraphy.** 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.

412. **Latin Elegy.** 1 unit. OLIVER.

413. **Caesar.** 1 unit. TURYN.

414. **Lucan.** 1 unit. OLIVER.

415. **Lucretius.** 1 unit.

416. **Vergil.** 1 unit. BATEMAN.

421. **Horace.** 1 unit.

422. **Plautus and Terence.** 1 unit. TURYN.

423. **Latin Romance.** 1 unit.

425. **Cicero.** 1 unit. TURYN.

426. **Tacitus.** The *Annales*. 1 unit. OLIVER.

427. **Roman Satire.** 1 unit. BATEMAN.

441. **Latin Paleography.** 1 unit. OLIVER.

491. **Directed Reading.** ½ unit. Prerequisite: Second-year graduate standing.

495. **Bibliography and Criticism.** Same as Greek 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Greek 496. ½ unit. OLIVER.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, NAOUMIDES, OLIVER, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Comparative Grammar of Greek and Latin.** Same as Greek and Linguistics 308. A historical study of the Greek and Latin languages through use of the comparative

method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

311. Advanced Latin Composition. Practice in the writing of Latin prose. ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. OLIVER.

312. Advanced Latin Composition. ½ unit. Prerequisite: Latin 311. OLIVER.

313. Oral Latin. Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.

391. Readings in Latin Literature. Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations*, Seneca, Ovid, Cicero's *Essays*, Patristic Latin, Medieval Latin. ¾ unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

Doctor of Philosophy in Communications. This program is administered by the Committee on Graduate Study in Communications, an interdepartmental committee under the jurisdiction of the College of Journalism and Communications. It provides a core program in communications and permits advanced specialization in several areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics.

The program applies the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communications. It is intended for students who plan careers in teaching communication subjects such as journalism, radio-television, and psycholinguistics; scholarly research on the development, control, and ethics of the mass media; experimental research on public opinion measurement; advertising, communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission is a 4.0 grade average and a broad background in the social sciences and humanities. Many of the advanced courses have introductory courses as prerequisites. An introductory course in statistics is generally useful.

A candidate for the Doctor of Philosophy in Communications must complete at least twenty-four units of graduate work. The program provides both an introduction to the broad field of communications with its related disciplines (requirements 1, 2, and 4, below), and specialization in a subfield (requirements 3 and 5). The student must meet these detailed requirements:

(1) Communications 471 and 472, Proseminar, two units.

(2) One unit selected from Group A (Communications 414, 432, 444, 462, 468, 470, 473, 474, 481, 483, 307, 308, 344, 360, 372), and one unit from Group B (Communications 420, 424, 425, 426, 456, 325, 351, 352, 370).

(3) An area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics (illustrated by Group B above). Occasionally the Committee will approve other specializations. Two units must be taken in courses in research methods; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research. Courses for the area of specialization are not limited to courses cross-listed with communications. With his adviser's approval, a student may offer any relevant graduate course as part of the major.

(4) Either a sole minor of four units in a discipline other than communications,

or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa*.) Courses cross-listed in communications may not be counted toward a minor in a discipline other than communications.

(5) Communications 499, Thesis Research, eight units.

(6) Language requirements of the Graduate College.

(7) A preliminary written and oral examination.

(8) A final oral examination centered on but not restricted to the field of the dissertation.

Minor. A candidate for the Doctor of Philosophy wishing to minor in communications should select four, three, or two units (according to the requirements of his major department). Communications 471 and 472 are recommended as giving a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background for the courses they choose.

Further information may be obtained from the chairman of the administrative committee, Professor Theodore Peterson, 119d Gregory Hall.

THE INSTITUTE OF COMMUNICATIONS RESEARCH

The Institute is an interdisciplinary group studying problems relating to the communications process and its role in society. Its staff consists of research professors, usually with joint appointments in the Institute an in related departments, and graduate student research assistants. The backgrounds of the staff range from linguistics, though psychology and the other social sciences, to journalism and other disciplines concerned with the mass media. Graduate students in the communications program often take part in the research activities of the Institute and have access to the personnel and facilities of this unit of the College of Journalism and Communications. Inquiries about the Institute should be addressed to its director, Professor Howard Maclay, 119 Gregory Hall.

GRADUATE FACULTY

Professors: T. Peterson (Chairman of Committee on Graduate Study in Communications), J. B. Casagrande, C. B. Hagan, J. E. Hulett, J. W. Jensen, H. L. Mueller, C. E. Osgood, C. H. Sandage, H. J. Skornia.

Associate Professors: M. E. Fishbein, L. Linsky, H. S. Maclay, Rita J. Simon.

Assistant Professors: J. W. Carey, Nancy Wiggins.

COURSES FOR GRADUATES

414. Seminar on Social Interaction. Same as Sociology 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of thoery, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

420. Seminar in Semantics. Same as Philosophy 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. Linsky.

424. Linguistics and Communication. Same as Linguistics 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. Maclay.

425. Psycholinguistics. Same as Linguistics and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory, and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the

development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Linguistics and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Communications 425; consent of instructor. MACLAY, OSGOOD.

432. **Books and Libraries Since the Renaissance.** Same as Library Science 432. The development of printing since the fifteenth century and its effect on the nature and use of the book; the growth of national, college, and university, public, and other libraries in Europe and America from the Renaissance to the present day. 1 unit. STEVENS.

435. **Fundamentals of Cybernetics.** Same as Biophysics 435 and Electrical Engineering 473. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 394 or Mathematics 361, or consent of instructor. ASHBY.

436. **Problems of Cybernetics.** Same as Biophysics 436 and Electrical Engineering 474. A continuation of Communications 435. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Communications 435. ASHBY.

444. **Seminar in Public Opinion.** Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

456. **Psychology of Social Communication.** Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

462. **Seminar in Radio and Television.** Same as Radio-Television 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. SKORNIA.

463. **World Broadcasting.** Same as Radio-Television 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor.

468. **The Political Ecomomy of Communications.** Same as Journalism 468. Analysis of the structure, policy, and behavior of such media of communications as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. GUBACK.

470. **Communications and Popular Culture.** Same as Journalism 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit.

471. **Proseminar in Communications, I.** Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control

and support; content, audience, and effect of the mass media. 1 unit. CAREY, STAFF.

472. **Proseminar in Communications, II.** Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. MACLAY, STAFF.

473. **History and Theory of Freedom of the Press.** Same as Journalism 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. JENSEN.

474. **Communications Systems.** Same as Journalism 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. CAREY.

481. **Advanced Advertising Principles.** Same as Advertising 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Communications 481 and Advertising 388. 1 unit. WEDDING.

482. **Research Methods in Advertising and Communications.** Same as Advertising 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. DUNN.

483. **Advertising and the Mass Media.** Same as Advertising 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit. MOYER.

490. **Special Topics in Communications.** ½ to 2 units. Prerequisite: Consent of chariman of Committee on Graduate Study in Communications. STAFF.

492. **Research Methods in Communications.** Same as Journalism 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. WIGGINS.

499. **Thesis Research.** 0 to 4 units. Students may reregister for a total of eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **The Art of the Screen: Narration.** Same as Speech 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. **The Art of the Screen: Exposition and Persuasion.** Same as Speech 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

325. **Introduction to Psycholinguistics.** Same as Linguistics 325. An introductory survey of psychological and linguistic approaches to the study of communication ½ or 1 unit. Prerequisite: An introductory course in linguistics or psychology MACLAY.

344. **Public Opinion.** Same as Sociology 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151 SIMON.

351. **Advanced Social Psychology.** Same as Psychology and Sociology 351. An integrative treatment of individual behavior variables in relation to group variables ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. MCGRATH, I. STEINER.

352. **Attitude Theory and Measurement.** Same as Psychology and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; a course in statistics. FISHBEIN.

360. **Educational Uses of Television and Radio.** Same as Educational Psychology and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

370. **Language, Culture, and Society.** Same as Anthropology and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

372. **Social Aspects of Mass Communications.** Same as Journalism and Sociology 372. Media structures related to cultural content and functions. Problems of life and society as treated in mass-produced communications. ½ unit. GUBACK.

COMPARATIVE LITERATURE

The program leading to the Master of Arts and Doctor of Philosophy degrees in Comparative Literature is designed to make possible a systematic study of subjects and problems common to several literatures. Its purpose is to enable students who have greater than average linguistic competence and preparation to explore (1) the interrelations of several literatures; (2) the main currents, periods, and movements in literary history; and (3) the theory of literature and criticism. The program is supervised by a committee made up of the heads and charimen of the classical and modern language and literature departments. The student's program of study is supervised by an adviser in the department of his major interest. A student entering the program should have attained an undergraduate grade average of 4.0 and must present evidence of having acquired a command of two foreign languages. Some knowledge of Latin (or Greek) is highly recommended; Latin is necessary for students planning to specialize in the Medieval or Renaissance periods; it may be required for students specializing in Neo-classicism and the Enlightenment.

Master of Arts. A candidate for the Master of Arts in Comparative Literature must offer eight units of credit (general requirement of the Graduate College); these must include four units in one literature, Comparative Literature 401, and two units of

credit in a second literature. The courses chosen from the second language and literature department must be approved by the adviser; and at least four of the courses, in addition to Comparative Literature 401, must be chosen at the 400 level. The candidate must also pass an examination based on a reading list and designed to test his knowledge of the literature of his main interest as well as his ability to interpret a literary or critical text. A master's thesis is not required, although the student may elect to offer one with the approval of his adviser.

Doctor of Philosophy. A candidate for the Doctor of Philosophy in Comparative Literature must fulfill the general requirements of the Graduate College including those specified above for the master's degree. He must choose at least four units of work from comparative literature seminars (451, 452, 461, 462). Four additional units of work at the 400 level are to be taken in courses regularly offered by the language and literature departments. The candidate is responsible for a knowledge of the history of the literature in one modern language. He must also select a period of major interest, and be responsible for a knowledge of two other literatures in this period, which are considered as minors. The periods may be either (1) Medieval, (2) Renaissance, (3) Neo-Classicism and the Enlightenment, or (4) The Modern Period. He must pass a preliminary examination (a three-part written examination, plus an oral examination), and present a thesis in which he has investigated a topic with ramifications of a comparative nature.

Inquiries concerning the program should be addressed to Professor François Jost, Director of the Graduate Program in Comparative Literature, 244 Lincoln Hall.

COURSES FOR GRADUATES

401. Theory of Literature. The methods and objectives of the discipline of comparative literature. 1 unit. Prerequisite: Reading knowledge of two foreign languages; consent of instructor.

451. Seminar in Literary Movements. An investigation of the development and mutation of literary movements (classicism, romanticism, symbolism, etc.) through a study of critical texts and their reception in various countries. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

461. Seminar in Literary Forms. A study of a form (the lyric, the novel, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

493. Special Studies. ¼ to 1 unit.

499. Thesis Research. Intended for students engaged in writing a thesis as a partial requirement for the A.M. or Ph.D. degree in Comparative Literature. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

See Humanities, page 212.

COMPUTER SCIENCE

The Department of Computer Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Computer Science. There is opportunity for specialization in circuit design, digital computer arithmetic, switching and automata theory, computer organization, computer applications in physical science, software systems and languages, numerical analysis, pattern recognition, and information retrieval.

The admission average is 4.0 for the last sixty semester hours of undergraduate work. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Course prerequisites are twenty semester hours of electrical engineering, mathematics, or physics, including Computer Science 201 and 294, and one course in either Computer Science 301, 387, 391, or their equivalents. Since this is an interdisciplinary program, applicants whose programs are deficient in some of these areas are considered individually.

The requirements for the Master of Science degree in Computer Science include a thesis, in addition to the general requirements of the Graduate College.

The requirements for the Doctor of Philosophy degree in Computer Science include satisfactory achievement on a qualifying examination covering the areas of computer design, computer programming, and numerical analysis, in addition to the general requirements of the Graduate College.

Further details of this program are available from the Department of Computer Science.

The department provides service computing facilities for the educational and research programs of the University. At present, the Illiac II and an IBM 7094/1401 system are operated. It is proposed to add an IBM 360/50 by mid-1967.

GRADUATE FACULTY

Professors: J. R. Pasta (Head of Department), L. D. Fosdick, D. B. Gillies, B. H. McCormick, S. Muroga, W. J. Poppelbaum, J. E. Robertson, D. L. Slotnick, J. N. Snyder (Associate Head of Department).

Associate Professors: C. W. Gear, T. A. Murrell, S. R. Ray.

Assistant Professors: H. G. Friedman, D. J. Kuck, J. Nievergelt.

COURSES FOR GRADUATES

400. Introduction to Automatic Digital Computing for Graduate Students. A beginning course covering the programming of digital computers using procedure oriented language. No graduate credit.

414. Engineering Applications of Linear Graphs. Same as Electrical Engineering 414. Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 315 or 318.

456. Coding Theory. Same as Electrical Engineering 456. General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

457. Advanced Numerical Analysis. Same as Mathematics 457. Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequisite: Computer Science or Mathematics 387, or consent of instructor.

458. Numerical Solution of Partial Differential Equations. Same as Mathematics 458. The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by iterative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Mathematics 455 or consent of instructor.

463. Information Theory. Same as Electrical Engineering and Mathematics 463. Mathematical models for information channels and sources; existence theorems

for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or Electrical Engineering 433.

465. Topics in Automata Theory. Same as Electrical Engineering and Mathematics 465. Topics selected from mathematical systems and automata theory, decision problems, formal languages, decomposition theory, etc. 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 392, or consent of instructor.

481. Threshold Logic. Same as Electrical Engineering 481. Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. Theory of Digital Arithmetric. Same as Electrical Engineering 482. This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Computer Science or Electrical Engineering 394.

485. Advanced Theory of Magnetic and Optic Computer Memory Devices. Same as Electrical Engineering 485. Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media: modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Computer Science or Electrical Engineering 385.

487. Theory of Approximation. Same as Mathematics 487. General approximation theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

490. Individual Study. Individual study or reading in a subject not covered in normal course offerings. ½ to 2 units. Prerequisite: Consent of instructor.

491. Seminar in Computer Science. Seminar on topics of current interest. Subjects will be announced in the Time Table. ½ to 1 unit. Prerequisite: Consent of instructor.

497. Special Topics in Computer Science. Lecture courses in topics of current interest. Subjects will be announced in the Time Table. ½ to 1 unit. Prerequisite: Consent of instructor.

499. Thesis Research. Section A, for master's degree candidates; Section B, for doctoral degree candidates. 0 to 4 units. Prerequisite: Consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Programming, Languages, and Computation. An introduction to mathematical models of programming languages and computation on a digital computer; phrase structure languages, particularly context free languages, and their syntactic analysis with application to translation; abstract models of digital computers and the computations which they can perform subject to various restrictions on control, memory, and time; unsolvability results for computations and languages. 1 unit. Prerequisite: Computer Science 101, 201, or consent of instructor.

311. Mathematical Theory of Data Processing. Mathematical structure and automatic processing of extensive files of data are developed employing methods from statistics, graph theory, and information theory. Topics discussed include: the

selective screening and classification of data (pattern recognition, machine abstracting, optimum encoding, least square adjustment of data); and file organization and maintenance (information retrieval, indexing, and scheduling). 1 unit. Prerequisite: Computer Science 101 or consent of instructor.

365. Digital Computer Methods for Statistical Data Processing. Same as Agronomy 365. A study of computing methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. 1 unit. Prerequisite: Computer Science 101 and a course in statistics or statistical methods, or consent of instructor.

385. Theory of Semiconductor Computer Devices. Same as Electrical Engineering 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization and noise theory; integrated circuits technology: masking, oxidizing, and etching; emphasis on development of device-theoretical background for computer logic design. ¾ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

387. Introduction to Numerical Analysis. Same as Mathematics 387. 1 unit. Prerequisite: Computer Science 101 and a course in differential equations, or consent of instructor.

391. Boolean Algebra and Switching Theory. Same as Mathematics and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Mathematics and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Electrical Engineering, Computer Science, or Mathematics 391, or consent of instructor.

393. Digital Computer Circuit Design. Same as Electrical Engineering 393. Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Computer Science or Electrical Engineering 294 or Computer Science, Electrical Engineering, or Mathematics 391; credit or registration in Electrical Engineering 382 or 383; or consent of instructor.

394. Logical Design of Automatic Digital Computer Circuits. Same as Electrical Engineering 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Electrical Engineering 294; consent of instructor.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology and microbiology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.75.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. Candidates for the Master of Science must complete one-half unit of seminar and two units of thesis research. For the Doctor of Philosophy, one and eight units, respectively, of these courses are required. Other course requirements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the Master of Science are expected to complete an acceptable thesis unless the Dean of the Graduate College waives this requirement. All students expecting to continue graduate studies should fulfill the thesis requirements for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science also is required.

For a minor in dairy science, students should select an adviser in this area of study to determine the specific courses required. For the Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science, of which two units must be in 400-level courses; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

GRADUATE FACULTY

Professors: G. W. Salisbury (Head of Department), H. P. Broquist, R. E. Brown, M. P. Bryant, K. E. Harshbarger, R. L. Hays, K. A. Kendall, B. L. Larson, R. W. Touchberry.

Associate Professors: J. H. Byers, C. L. Davis, J. R. Lodge, M. J. Wolin.

Assistant Professor: C. N. Graves.

COURSES FOR GRADUATES

402. The Microbiology and Physiology of Ruminant Nutrition. The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. ¾ unit. Prerequisite: Chemistry 350, 355, or equivalent. Brown, Bryant.

408. Physiology of Lactation. The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. ½ to 2 units. Hays.

411. Population Genetics and Animal Breeding. Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. Touchberry.

412. Advanced Endocrinology. Same as Animal Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. This course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. Gorski, Nalbandov.

430. Physiology of Mammalian Germ Cells. A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. Lodge, Salisbury.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Forestry, Horticulure, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. SEIF.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Forestry, Horticulture, and Veterinary Medical Science 441. A continuation of Dairy Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Dairy Science 440 or equivalent. CARMER.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. ½ to 2 units. Prerequisite: Ten hours of advanced microbiology and/or chemistry; consent of instructor. BRYANT, WOLIN.

490. **Dairy Science Seminar.** Current literature relating to various phases of dairy science. ½ unit. Prerequisite: Graduate major or minor in dairy science. SALISBURY.

493. **Special Problems.** Individual investigations in any phase of dairy science. ½ to 2 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

499. **Thesis Research.** 0 to 4 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** Supervised research on any phase of dairy science, including bacteriology and microbiology, biochemistry, feeding and nutrition, genetics, and physiology. ½ or 1 unit. Prerequisite: Approval of head of department. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

305. **Genetics and Animal Improvement.** Same as Animal Science 305. The principles of heredity and their application to the problem of animal improvement. ¾ unit (Summer Session, ½ unit). Prerequisite: Dairy Science 110 or equivalent. DEFRIES, RASMUSEN, TOUCHBERRY.

330. **Reproduction and Artificial Insemination of Farm Animals.** Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. GRAVES, LODGE.

334. **Marketing Dairy Products.** Same as Agricultural Economics 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230, an elementary marketing course, or twelve hours of dairy science or dairy technology. BARTLETT.

381. **Dairy Biochemical Laboratory Methods.** Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, microrespiration, and others. 1 unit. Prerequisite: Quantitative analysis; organic chemistry; consent of instructor. Biochemistry is recommended. LARSON.

DANCE

The Dance Division offers a program of graduate study leading to the Master of Arts in Dance. This program offers advanced work in choreography, dance production, and pedagogy, with emphasis on the related fields of art, music, and theatre, and is administered by the supervisor of the Dance Division and an interdisciplinary committee composed of representatives from the Department of Art, the Department of Speech and Theatre, and the School of Music.

Admission requirements for a major in this field are: (1) a minimum grade-point average of 3.5; (2) twenty-four semester hours of approved undergraduate credit in dance (at least eight hours), art, music, theatre, and physical education; (3) thirty-six semester hours in humanities (literature, language, and philosophy), natural sciences (biological and physical sciences), and social sciences (history, political science, psychology, anthropology, sociology, education). Applicants lacking a portion of the prerequisites under item (2) may substitute certified experience in dance not to exceed eight semester hours.

Satisfaction of the general requirements for admission to the Graduate College and to this program does not in itself necessarily qualify the student as a degree candidate. The supervisor of the Dance Division also reserves the right to accept for advanced study only those students whose preparation in dance has been obtained in certain approved institutions.

Of the eight units required for the Master of Arts, a minimum of four must be in dance, or (subject to the approval of the supervisor) in dance and related areas such as art, music, theatre, speech, physical education, and recreation; two units must be in one or more of the following fields: English, history, philosophy, anthropology, psychology, sociology, radio-television. The remaining two units are for the presentation of an acceptable thesis (Dance 499) and the accompanying noncredit course, Dance 490, Seminar. The thesis may be waived, with the approval of the adviser, but in lieu thereof the candidate must submit two units of course work (total of eight units), plus a recital of solo and group dances which he has choreographed and staged.

Not later than midpoint in the student's program, his work is reviewed in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The supervisor of the Dance Division may extend the residence requirement (or increase the total requirements) at this time or any other time, if this seems warranted.

GRADUATE FACULTY

Professor: Margaret Erlanger (Supervisor of Dance Division).

Assistant Professors: Joan Skinner, W. W. Ward, Jr.

Instructor: A. R. Thomas.

COURSES FOR GRADUATES

400. Problems in Dance Education. Basic historical, philosophical, and scientific foundations and developments in dance education; teaching methods; development of compositional problems; creative methods of instruction; organizational problems of dance groups and public dance performance. 1 unit. Prerequisite: Dance 243 or 244, or equivalent. Erlanger.

401. Choreography. Experience in choreographing a minimum of one solo and one group composition to be presented at the end of the semester. ½ to 2 units. Prerequisite: Dance 345 or equivalent. Students may reregister for a maximum of two units with the permission of the supervisor of the Dance Division. Staff.

490. **Dance Seminar.** Student presentation of thesis reports in dance; informal discussions, demonstrations, lectures, and critical analysis of current problems in dance by professional guests. No credit. STAFF.

499. **Thesis Research.** Preparation of theses in dance. ½ to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **History of Dance.** A survey course tracing dance from its beginnings in primitive societies to its present art form. ½ unit. Prerequisite: Consent of instructor. ERLANGER.

345. **Dance Production Workshop.** Experience in choreography and production of group compositions with special emphasis on staging, lighting, and costuming. ½ unit. Prerequisite: Dance 164 or equivalent; consent of instructor. STAFF.

346. **Theory and Philosophy of Dance.** A study of the relationship of aesthetic principles and dance theory to a philosophy of dance in education and of dance as a performing art. ½ unit. Prerequisite: Consent of instructor. THOMAS.

ECONOMICS

The Department of Economics offers graduate work leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

A student who applies for admission to graduate study in economics must have a grade-point average of 4.0 or higher. Students with averages between 3.75 and 4.0 are considered on an individual basis. Applicants must have completed fifteen hours of undergraduate work in economics or have approval of the Director of Graduate Studies. The department recommends that the results of the Graduate Record Examination Aptitude Test accompany application for admission to the Graduate College. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

The candidate for an advanced degree in economics may specialize in the following fields of economics: economic theory, history of economic thought, monetary theory and policy, public finance and taxation, growth and development, international economics, mathematical economics, labor economics, economic history, comparative economic systems, transportation, econometrics, and relations of government and business.

Master of Arts or Master of Science. The following requirements must be met:

(1) Economic Theory. Two units of course work, consisting of 400-401, or 402-403; if the student has had 300-301 or their equivalent, he must take 402-403.

(2) Statistics. Proficiency in statistical analysis. This requirement may be met by taking Economics 470 or by passing a proficiency examination.

(3) History of Economic Thought or Economic History. One unit in either field at the 400 level. Two units are recommended.

(4) Course work beyond that required to bring the total to eight units, two of which may be master's thesis work, or successful completion of the written qualifying examination for the doctorate.

Doctor of Philosophy. The following requirements must be met:

(1) Economic Theory. Economics 402-403, plus one additional 400-level course in advanced economic theory.

(2) Statistics. The same demonstration of proficiency as for the master's degree.

(3) History of Economic Thought and Economic History. Passing a written preliminary examination in these subjects with one unit of 400-level course work in each.

(4) Specialized Fields. The student must select three additional fields, two of

which must be in economics, and the third outside the department. At least two units of graduate work in courses in each field selected are required.

(5) Additional units to bring the total to twenty-four, of which eight must be doctoral dissertation units.

The candidate is required to pass examinations in two foreign languages, an oral and written preliminary examination prior to beginning dissertation research, and an oral final examination covering his research.

GRADUATE FACULTY

Professors: J. F. Due (Chairman of Department), V. L. Bassie, R. Brandis, H. J. Brems, R. Ferber, D. P. Flanders, M. Frankel, R. W. Harbeson, D. R. Hodgman, D. L. Kemmerer, E. B. McNatt, W. H. McPherson, W. A. Neiswanger, D. W. Paden, J. B. Parrish, J. D. Phillips, P. J. Wells.

Associate Professors: D. J. Aigner, Grace Beckett, H. W. Folk, R. W. Gillespie, F. M. Gottheil, A. J. Heins, W. W. McMahon, H. O. Nourse, R. W. Resek, P. Schran, F. R. Shupp, C. M. Sprenkle, S. W. Steinkamp, Janet L. Weston, T. A. Yancey.

COURSES FOR GRADUATES

400. **General Economic Theory.** Emphasis in this course is placed on micro-economic theory. The principal topics include: a review of value and distribution theory, the theory of choice by household, and firms general micro-economic theory, and theoretical developments of current interest. Attention is given to empirical studies intended to affirm or disaffirm economic principles. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders.

401. **General Economic Theory.** Emphasis in this course is placed on macro-economic theory and the relationship of economics to the other social sciences. The principle topics include: a review of Keynesian macro-economic theory, formal growth theory, selected business cycle theory, the theory of socio-economic change, and an outline of the differentiation and integration of economics and other social sciences. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders, Staff.

402. **Economic Theory.** This course develops modern micro-economic theory: utility functions and demand; production functions and cost; linear programming; price and nonprice policy by the firm; market equilibria; income distribution; general equilibrium including input-output analysis. The course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. Staff.

403. **Economic Theory.** This course develops modern macro-economic theory; the Keynesian model of employment, interest, and money; its extension to international trade; fiscal policy and macro-economic theory of disbribution; the consumption function; the theory of growth and cycles in terms of difference and differential equations. This course is given in two sections one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. Staff.

406. **History of Economic Thought.** An analysis of economic thought from the Physiocrats to the present; the materials selected are evaluated both as reflections

of their times and as contributions to contemporary thought. 1 unit. Prerequisite: Six hours of economics. BRANDIS, GOTTHEIL.

410. **Price and Distribution Theory.** A research-oriented seminar in micro-economic theory. Major topics treated include: comparative static analysis of demand, production, and the theory of markets; dynamic equilibrium; market dynamics. Sub-topics include axiomatics of preferences; ordinal and Bernoullian utility, revealed preference, and the interdependence of preferences; multiperiod production, utility, and consumption; the aggregation of micro-economic relationships; expectations and response lags; analysis of changing market structures; game theory. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 402 and 470, or equivalent. AIGNER.

411. **Capital and Interest Theory.** A comprehensive and critical examination of the theory of capital and interest as the subject has been developed by the leading English and continental writers. Special attention is given to the optimal investment decision of the firm, capital accumulation and the efficient utilization of society's resources, and to the relation between capital and interest. Offered in 1967-1968 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, SPRENKLE, WELLS.

412. **Advanced Aggregate Income Theory.** An analysis of the theory of income and employment with emphasis upon the measurement of income and product, money flows, and the relationship between input and output in the economy. Offered in 1967-1968 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, PADEN, WELLS.

413. **Consumption Theory.** The theory of consumer behavior in modern economic analysis. Utility analysis at the micro level, consumer interdependence and problems of aggregation, econometric tests, aggregate consumption analysis in static and dynamic contexts, and the implications of the theory of consumer behavior for cyclical movements and economic growth. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 400 or 402, or consent of instructor. FERBER, MCMAHON.

414. **Public Finance.** Analysis of government expenditures and decision making; the budgetary process; fiscal policy; government borrowing and debt management; intergovernmental fiscal relations; pricing of government services; public finance in developing economies. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

415. **Economics of Taxation.** Principles of taxation; incidence and distribution of tax burden; economic analysis of the major taxes: the personal and corporate income taxes, sales and excise taxes, property tax, and others; taxation and economic development. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

420. **Monetary Theory.** A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the quantity theory, liquidity preference, the demand for money, velocity, theories of the level and term structure of interest rates, asset theory, and money in static and dynamic macro-general equilibrium models. 1 unit. Prerequisite: A course in income and employment theory or consent of instructor. HODGMAN, SPRENKLE.

421. **The Theory of Monetary Policy.** Theories of central banking, debt management, financial intermediaries, and the monetary behavior of firms and households are used to explore current issues in the theory of monetary policy. Current empirical research is reviewed with particular emphasis on econometric studies of monetary behavior. 1 unit. Prerequisite: A course in money and banking, in macro-economic theory, calculus, and statistics, or consent of instructor. HODGMAN, SPRENKLE.

425. **Macro-Accounting.** Same as Accountancy 455. An examination of the fundamental concepts underlying the attempt to measure the economic activities of

macro-units; similarites and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals, 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor.

428. **International Trade Theory.** The neoclassical theory of international trade is developed and then used for the analysis of tariffs, customs, unions, and the effects of trade on the distribution of income and welfare. The relations between the balance of payments and national income are analyzed and used to study the role of income changes combined with price changes in the balance of payments adjustment process. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. GILLESPIE.

429. **International Trade Policy.** Concepts of balance of payments equilibrium, the foreign exchange market and the theory of capital movements; current problems and policies related to balance of payments desequilibrium, trade policy, and the functioning of the international monetary system. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. CUMMINGS, GILLESPIE.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, foreign and domestic commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 236. 1 unit. KEMMERER.

438. **Economic History of Europe.** The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, industrialization, etc. 1 unit. Prerequisite: Consent of instructor.

440. **Labor Economics.** Same as Labor and Industrial Relation 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

441. **Labor Economics.** Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

442. **Collective Bargaining.** Same as Labor and Industrial Relations 442. The development of a theory of the continuing interactions between unions and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and governmental process. 1 unit. Prerequisite: Consent of instructor.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Labor and Industrial Relations 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling, analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

444. **Economics of Manpower Resources.** Same as Labor and Industrial Relations 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. PARRISH.

447. **Labor Union Organization and Administration.** Same as Labor and Industrial Relations 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. GARMAN.

450. **The Economics of Development and Growth.** Review and analysis of the theories and patterns of growth in developed and underdeveloped economies. The problems and methods of measuring growth are considered, the variables thought to be strategic in the growth process are critically examined, and the policy implications of different theories are explored. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. FRANKEL, HARRIS.

451. **The Developing Economies.** An analysis of the newly-developing economies, with emphasis on institutional factors affecting development, and economic policy relating to development. 1 unit. Prerequisite: Economics 450. STAFF.

455. **Comparative Economic Systems.** A comparative analysis of the structures and policies of market-directed and planned economies. 1 unit. Prerequisite: Economics 103 or 108 or equivalent. GOTTHEIL.

457. **Economic Planning in the Soviet Union and Eastern Europe.** An intensive examination of the structure and performance of the Soviet and the East European economies, emphasizing analysis of the main theoretic and operational dimensions of economic planning; choice, design, and efficacy of central planning instruments are evaluated from both theoretical and historical perspectives. 1 unit. Prerequisite: Economics 357, 450, or 455, or a reading knowledge of Russian. MILLAR.

460. **Location Theory.** The theory of location of economic activity in modern economic analysis; production and location theories are synthesized and applied to regional structure and interregional and international trade and development. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. NOURSE.

467. **Economic Activity Analysis.** Selected topics in economic theory are analyzed with the aid of mathematical programming, input-output analysis, set theory, and game theory. Existence, optimality and stability conditions for static and dynamic general equilibrium phenomena are emphasized, and such related topics as welfare economics and capital accumulation may be treated. Offered in 1967-1968 and in alternate years. 1 unit. Prerequisite: Consent of instructor. BREMS, SHUPP.

468. **Economic Dynamics.** The course is devoted to the study of the behavior of aggregate output and income over time. Mathematical models are developed of long-run growth and short-run cycles, as well as the interactions between the two. Familiarity with first-order, second-order, and higher order single difference equations as well as systems of difference equations is acquired in the course. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 403. BREMS.

470. **Economic Statistics.** Classical statistics and regression analysis; descriptive statistics, probability, point and interval estimation, decision theory, variance analysis,

linear regression and least squares estimates. 1 unit. Prerequisite: Consent of instructor. NEISWANGER.

471. **Economic Statistics.** Part 1: the construction of econometric models; characteristics of models and choice of estimating methods; estimates of parameters by various methods Part 2: Bayesian statistics and decision theory. 1 unit. Prerequisite: Economics 470 or equivalent. NEISWANGER, YANCEY.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information, selecting critical factors, and appraising the validity of analytical techniques. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 170 and 312 or 373 or equivalents. BASSIE.

474. **Operations Research.** A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, dynamic programming, queueing theory, renewal theory, and simulation methods are applied to economic control systems with special emphasis on the problems of the firm. Offered in 1967-1968 and in alternate years. 1 unit. Prerequisite: Mathematics 363 and Economics 374 or equivalent. AIGNER, SHUPP.

476. **Econometrics, I.** Estimation of parameters for single equation models; tests of hypotheses and confidence regions for regression models; large sample theory in single equation models; Bayesian statistics in regression models. 1 unit. Prerequisite: Mathematics 315 and 363. RESEK, YANCEY.

477. **Econometrics, II.** Specification of models with systems of simultaneous equations; identification problem, distributed lag models, K-class estimators, maximum likelihood estimators, three stage least squares, and effects of specification errors are considered. 1 unit. Prerequisite: Economics 476. RESEK, YANCEY.

479. **Research Seminar in Quantitative Economics.** Significant work in the area of quantitative economics is reported and explored by members of the instructional staff, by guest speakers from academic, governmental, and industrial centers, and by graduate students in the second year of their work who are assigned projects. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: The equivalent of one year of graduate statistics (theoretical or applied), calculus, and the equivalent of one year of mathematical economics. FERBER.

480. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit.

481. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

490. **Individual Study and Research.** Directed reading and research. ½ to 1 unit. STAFF.

499. **Thesis Research.** Preparation of thesis required of all students writing master's or doctor's theses in economics. 0 to 4 units; Summer, 0 to 2 units. Master's theses, FLANDERS; doctor's theses, FRANKEL.

COURSES FOR GRADUATES

300. **Intermediate Micro-Economic Theory.** Micro-economic analysis including value and distribution theory. Topics include the analysis of demand, the theory of the firm and the industry, and the analysis of the pricing of the factors of production. Each topic is integrated in a micro-general equilibrium context which builds toward explaining the resource allocation process. ½ unit. Prerequisite: Economics 103 or 108. Students may not receive credit for both Economics 200 and 300. STAFF.

301. **Intermediate Macro-Economic Theory.** The modern theory of the determination of the level and rate of growth of income, employment, output, and the price level. Alternate fiscal and monetary policies to facilitate full employment and economic growth are discussed. Prerequisite: Economics 103 or 108. ½ unit. STAFF.

302. **Economic Analysis.** An introduction to the theory of income and employment, price and allocation, and instability and growth. S; ½ or 1 unit. Prerequisite: Economics 103 or 108, enrollment in National Science Foundation Summer Institute in Economics, or consent of instructor. PADEN.

306. **History of Economic Thought.** A study of the development of economics. Contributions of schools of thought and individual writers are examined in their. settings and as they influenced economic thought and national policy. ½ unit. Prerequisite: Economics 103 or 108.

312. **Economic Dynamics and Growth.** An analysis of the causes of economic instability; the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. ½ or 1 unit. Prerequisite: Economics 108, or 103 and 301.

313. **Economics of Consumption.** Same as Home Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

329. **International Trade Policy.** Analysis of the trade policies of selected countries, with particular reference to the United States; study of the relationships between international trade policy and the theory of international trade and finance. ½ or 1 unit. Prerequisite: Economics 103 or 108. BECKETT.

335. **American Financial History.** American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banking and of other financial institutions, and the financing of government, especially of major wars. ½ or 1 unit. Prerequisite: Finance 250. KEMMERER.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history.

342. **Economics of Social Security.** Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108. MCNATT.

343. **Collective Bargaining.** Emergence of collective bargaining in American industry, national labor policy and bargaining; impact of bargaining on union and management structures and policies; bargaining processes and techniques; the labor agreement including contract provisions, grievance procedures, arbitration; economic consequences of bargaining; case studies of union-management relationships and problems. ½ or 1 unit. Prerequisite: Economics 240. PARRISH.

344. **The Law and Labor.** Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240. McNatt.

349. **Senior Seminar in Labor Economics.** Pre-professional capstone course intended to unify other courses in labor economics and closely related fields. Included are studies of research techniques and sources; individual readings in current literature; preparation of research reports and papers; consideration of professional employment opportunities and graduate study in labor economics and industrial relations. ½ or 1 unit. Prerequisite: Economics 240; consent of instructor. Parrish.

352. **Economic Development in Latin America.** A study of economic activity and the process of diversification and industrialization in Latin America, with comparative analysis of selected countries. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. Beckett.

353. **Economic Development in India and Southeast Asia.** Analysis of plans and progress toward economic development in India and Southeast Asia; economic characteristics of the area and their significance for economic development. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. Cummings.

357. **The Soviet Economy.** Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. Hodgman.

358. **The Economy of China.** Discussion of changes in the patterns of production, exchange, and distribution in Communist China, with emphasis on their relation to social transformation. Survey of Chinese economic history over the past century, dealing with the institutional background to and the structure of economic activities in China. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. Schran.

360. **Regional Economic Development.** A survey of the theory and problems of regional economic development, including regional accounts, interregional income and trade theory, principles of the location of economic activity, theories of regional growth, and public policy for development of regions. ½ or 1 unit. Prerequisite: Economics 103 or 108. Nourse.

366. **Mathematical Analysis in Economics.** This course is designed to acquaint the student with the application of mathematical techniques to economic theory, especially general equilibrium theory. ½ or 1 unit. Prerequisite: Economics 103 or 108; some knowledge of calculus.

371. **Sampling Theory and Technique.** Design of samples useful in economic and business research. Problems considered relate to the efficiency of sample designs, cost limitations, bias, non-sampling errors, and interpretation of results. Sampling theory is applied to specific sampling problems through the use of electronic computers. ½ or 1 unit. Prerequisite: Economics 173 or equivalent.

374. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of linear programming and dynamic programming, game theory, probability theory, queueing theory, and inventory theory. ½ or 1 unit. Prerequisite: Economics 170 and Industrial Administration 101, or consent of instructor.

384. **Economics of Transportation.** Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. ½ or 1 unit. Prerequisite: Economics 103 or 108. Harbeson.

386. **Current Transportation Problems.** An analytical and critical study of selected problems of current interest in transportation. ½ or 1 unit. Prerequisite: Economics 384. HARBESON.

389. **Industrial Competition and Monopoly.** The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

EDUCATION

(Including Educational Administration and Supervision, Educational Psychology, Elementary Education, History and Philosophy of Education, Secondary and Continuing Education, Special Education, and Vocational and Technical Education)

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology (including a special program in psychology of classroom learning and instruction), elementary school teaching, early childhood education, teaching of reading, guidance and counseling (including rehabilitation counseling), history and philosophy of education, measurement and evaluation, research methods, school psychology, or any of the fields of seconday school education: English, home economics, industrial education, mathematics, modern languages, physical education, science, and social science.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher and undergraduate preparation appropriate to advanced study in the chosen major. Applicants who hold bachelor's degrees in fields other than teacher education are considered on an individual basis. See admission requirements for the Master of Education.

Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College (see pages 41 and 42), the following regulations apply to programs leading to the Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of not more than two units is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312 are required.

Doctor of Philosophy. The general requirements of the Graduate College pertaining to the Doctor of Philosophy must be met. (See pages 42 to 45.) To become a candidate for the Doctor of Philosophy with a major in education, the applicant must hold a master's degree with a major in education or some appropriately related subject. An applicant who has not written a master's thesis will be required to prepare and submit a paper equivalent to a master's thesis. The applicant should present credentials well in advance of his first registration. Required examinations and other steps preliminary to admission must be completed prior to the registration period. Admission is not complete until the student has been accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Applicants holding bachelor's degrees in fields other than teacher education may be considered individually for admission to the program leading to the Master of Education. Applicants admitted with deficiencies in professional education or for teacher certification will be required to take a limited number of undergraduate courses. Such courses will not be counted in the eight units of graduate work required for the Master of Education.

In general, the professional education requirements for the Master of Eudcation and for teacher certification may be fulfilled through proficiency examination in Educational Psychology 211, an appropriate methods course at the undergraduate level, student teaching, History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. However, an applicant admitted with deficiencies should expect to take additional courses in the teaching subject fields.

Those preparing for teaching at the secondary level must have completed a minimum of thirty-two semester hours of appropriate course work in the first teaching field, if elected, and from twenty to twenty-four semester hours of credit in a second teaching field. Previous course work in such fields will be evaluated and considered in determining the eligibility of a student for teacher certification.

Graduate students admitted with deficiencies for teaching in the elementary schools will be required to complete Illinois teacher certification requirements through appropriate undergraduate and graduate course work.

The advisers of students admitted with deficiencies will develop programs in which a maximum number of teacher certification requirements are met through courses also acceptable in fulfillment of master's degree reqiurements. Students admitted with no deficiencies can complete requirements for the Master of Education through full-time study in two semesters. However, students admitted with deficiencies for certification should anticipate from one to two additional semesters of course work.

Program. At least eight units of course work, including four units in education, are required. History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312 are required, except from students who pass proficiency examinations in these courses.

There may be one or two minors. In general, candidates for the Master of Education are expected to take at least two units in fields other than education, particularly if the specialization is in secondary education. One unit at the 300 level in the teaching subject or subjects may be substituted for one of the three units at the 400 level otherwise required. Courses at the 200 level in the teaching subject or subjects may be taken for graduate credit subject to the prior approval of the Dean of the Graduate College, but total credit in such courses may not exceed two units. Credit earned in such courses can not be applied to the requirements for the Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Residence. At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years' successful professional employment in education are required.

Program. A year of specialized professional study is required. Of the eight units of course work required, at least four must be in courses at the 400 level. Students who have not previously taken History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312, or equivalents, must take them or pass proficiency

examinations. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education. The program must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy.

Residence. The residence requirement is similar to that for the Master of Education.

Doctor of Education. Programs leading to the Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Applicants for admission should present credentials well in advance of the date for their first registration. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Program. Sixteen units of course work beyond the master's degree are required. Extramural course work may not be included in this sixteen-unit requirement. (Exceptions may be made for Educational Psychology 413 and Educational Administration and Supervision 461, 462, and 463.) A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

History and Philosophy of Education 410 and Educational Psychology 415 and 496 are required (note prerequisites).

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission and must pass a comprehensive written examination before he may enter the oral preliminary examination.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

The thesis required for the Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the examinations, filing of thesis titles, and the preparation, submission, and publication of theses must be met.

Residence. Minimum residence requirements are (1) two consecutive semesters, at least three units each, or (2) one semester, at least three units, and the summer session immediately preceding or following, at least one and one-half units, plus an additional summer session, at least one and one-half units.

Doctor of Education in Art Education. Doctor of Education candidates whose major field of study is art education follow programs for which the College of Education and the Department of Art share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the Department of Art. For further information, see page 79.

Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the

College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 286.

SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an intern. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program are subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

SPECIAL EDUCATION

Graduate study in special education is available at the master's degree, advanced certificate, or doctoral levels. Master's degree programs require one to two years and are designed primarily to prepare teachers of the culturally deprived, deaf, emotionally disturbed, gifted, mentally retarded, and children with learning disabilities. The advanced certificate requires at least a year of study beyond the master's degree and emphasizes preparation for supervision and administration of programs of special education. Doctoral programs require three or more years of advanced graduate study and are designed to prepare administrators, college instructors, and researchers in the various fields of special education indicated above. Special admission requirements apply to all graduate programs in special education. Further information concerning programs, admission requirements, and financial assistance may be obtained from the Chairman of the Graduate Selection Committee, Department of Special Education, 210 Education Building.

CLASSROOM LEARNING AND INSTRUCTION

Students planning to specialize in research and/or collegiate instruction in the educational psychology of classroom learning and instruction may become candidates for either the Doctor of Philosophy or the Doctor of Education. Doctor of Philosophy candidates major in education and minor in psychology or take a split minor with psychology and a related area, such as communications, or a subject such as mathematics, chemistry, or social studies. The program of study for the doctorate degree requires a minimum of three years of graduate study, including six months of internship. After an applicant is admitted, his study program is subject to review by one of the advisers associated with the program. A required core program consists of Educational Psychology 412, 449, 490, 492, 496, 497, and Psychology 418 and an internship of six months' minimum duration. The doctoral dissertation is generally written in the area of the nature, conditions, and improvement of classroom learning and instruction.

REHABILITATION COUNSELING

Students pursuing the Master of Education degree who plan to specialize in counseling and guidance normally require two academic years to complete this program, the fourth semester being devoted to supervised practice in an agency or institution located away from the campus. Doctoral programs also may be arranged to emphasize the study of rehabilitation counseling. Further information may be obtained from the Division of Counseling and Guidance, College of Education.

GRADUATE FACULTY

Professors: R. N. Evans (Dean of College of Education), C. M. Allen, E. W. Anderson, J. M. Atkin, F. P. Barnes, M. Beberman, C. E. Bereiter, G. M. Blair, H. S. Broudy, J. R. Burnett, R. W. Burnett, J. J. DeBoer, B. Farber, F. H. Finch, J. J. Gallagher, N. E. Gronlund, J. T. Hastings, K. B. Henderson, R. A. Henderson, W. P. Hurder, D. M. Jackson, R. S. Jones, M. R. Karnes, W. V. Kaulfers, G. C. Kettelkamp, Colleen J. Kirk, S. A. Kirk, C. G. Knapp, K. M. Lansing, Celia B. Lavatelli, L. E. McCleary, J. E. McGill, C. J. McIntyre, W. P. McLure, L. E. Metcalf, P. V. Miller, W. J. Moore, T. E. Newland, M. M. Ohlsen, C. H. Patterson, L. J. Phipps, R. E. Pingry, F. C. Proff, H. C. Quay, S. P. Quigley, R. M. Raubinger, C. W. Sanford, H. A. Schultz, J. H. Shores, Elizabeth Simpson, R. H. Simpson, J. M. Slater, B. O. Smith, R. E. Stake, W. O. Stanley, L. M. Stolurow, M. R. Sumption, M. Tatsuoka, L. R. Tucker.

Associate Professors: R. C. Anderson, P. Braunfeld, A. L. Brophy, R. J. Colwell, C. B. Cox, J. A. Easley, Jr., D. C. Epperson, L. A. Fisher, J. G. Froehlich, O. E. Gould, P. E. Hemp, Laura J. Jordan, H. Kaczkowski, Merle B. Karnes, H. H. Lerch, T. Manolakes, Mary Mather, F. McMurray, Elizabeth Melson, W. R. Powell, W. J. Schill, W. L. Shoemaker, P. B. Shoresman, R. E. Spencer, B. Spodek, R. A. Tinkham, J. R. Warmbrod.

Assistant Professors: T. H. Boardman, J. D. Boney, N. R. Dodl, Jo Ann Fley, G. R. Fuller, G. V. Glass, O. L. Hurley, Jean Phillips, W. M. Rogge, R. A. Smith, Hazel Spitze, O. L. Springer, R. M. Tomlinson, J. L. Walker.

Educational Administration and Supervision

COURSES FOR GRADUATES

430. **Elementary School Organization and Administration.** Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the elementary school. Examination is made of administrative roles in the design, implementation, and improvement of the total educational program. Intensive use is made of research skills and strategies in the investigation of problems of instruction. 1 unit. Prerequisite: Consent of instructor. Barnes, McGill, Springer.

438. **Instructional Supervision.** Methods, theories, and research applying to supervision at all levels of public education. Analyses are made concerning the work of curriculum directors, general supervisors, special supervisors, supervising principals, and department heads. Study of supervisory methods, current plans for staff utilization, use of instructional materials, evaluation of educational programs, and evaluation of the effects of supervision are stressed. 1 unit. Prerequisite: Elementary Education or Secondary and Continuing Education 439; Educational Administration and Supervision 460. Sergiovanni, Springer.

440. **Administration and Supervision of Junior and Senior High Schools.** Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the secondary schools. Problems are then projected through case studies and situational descriptions as a means of examining tasks and processes in such areas as curriculum and instruction, pupil and staff personnel, student activities, school organization,and management and school-community re-

lationships. 1 unit. Prerequisite: Educational Administration and Supervision 460 or consent of instructor. CARVER, DOOLITTLE, ROWE, SERGIOVANNI.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

460. **Public Control and Administration of Education.** A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective administrative officers and supervisors. Not open to experienced administrators nor to students who have taken any of the following courses (or equivalents): Educational Administration and Supervision 430, 440, 461, 462, 464, 465, 466. 1 unit. CARVER, MILLER, RAUBINGER, ROWE, SPRINGER.

461. **Administration of Educational Programs and Personnel.** Study of principles and criteria for analysis of programs at various levels of operation, such as intructional departments and pupil personnel service units, individual schools, local school systems, intermediate units, state education departments, and the federal government. Similar study is given to analysis of personnel requirements at various levels of operation. Educational Administration and Supervision 461, 462, and 463 constitute the required core program for all students specializing in educational administration who are candidates for a degree beyond the master's. 1 unit. Prerequisite: Educational Administration and Supervision 460 and 430 or 440. MILLER, ROWE, SERGIOVANNI, SPRINGER.

462. **Financial and Operating Structures of Public Education.** Study of relations of public education to the national economy; organization and operation of public school government; an analysis of theory and practice in school finance; processes of managing business affairs; role of law in school administration; and methods of survey, evaluation, and planning. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 461. MCLURE, RAUBINGER, ROWE.

463. **The Role of Administrative Leadership.** Study of principles underlying administrative leadership drawn from such disciplines as philosophy, psychology, sociology, and public administration. Application of these principles in the analysis and formulation of general procedures by which the process of administration may be carried on most effectively to develop and operate efficient educational programs. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 462. MILLER, RAUBINGER, SERGIOVANNI.

464. **Field Problems in Educational Administration.** Designed to give direct experience in the study of educational problems of concern to administrators. Each student selects and pursues one or more problems of study under the supervision of a professor. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

465. **Personnel Administration.** Principles, problems, and trends in the administration of professional public school personnel: organization of personnel; assessment and definition of personnel needs; recruitment, selection, and induction; evaluation; personnel development programs; and teacher organizations. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 461.

466. **Public School Finance.** Advanced graduate study of the theory and technology of public school finance. Attention is centered on analysis of principles and theory underlying fiscal practice in various states; technical knowledge of designing controls, organization, and fiscal systems in harmony with expressed theory; and the application of research to the analysis of problems related to the improvement

of financing public schools. 1 unit. Prerequisite: Educational Administration and Supervision 462 or consent of instructor. McLure.

468. **School-Community Relations.** Study of the relationship of the American school to the community. Analysis of the power structure, social agencies, school liaison groups, and economic character of the community as they affect and are affected by the school. Includes an evaluation of the various media of communication between the school and the larger community, and the development of criteria for an effective program of school-community relations. 1 unit. Raubinger, Sumption.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupil, parents, teachers, administrators, and school board members in relation to the school. 1 unit. Sumption.

470. **Principles and Resources for School Plant Planning.** Study of principles for planning functional school buildings. Primary emphasis is placed on the planning process involved in meeting the building needs of the school district, including (1) analysis and projection of educational programs to be housed, (2) prediction of pupil enrollments, (3) site selection, (4) educational specifications of buildings, and (5) rehabilitation, remodeling, and modernization of existing buildings. 1 unit. Prerequisite: Educational Administration and Supervision 460. Rowe.

490. **Seminar for Advanced Students of Education.** Seminar in educational administration and supervision open only to persons who have been admitted for doctoral study in educational administration and supervision. 1 to 2 units. Staff.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. Staff.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. Staff.

Educational Psychology

COURSES FOR GRADUATES

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundations, and its implications for education. 1 unit. Prerequisite: Educational Psychology 311 and 312. Blair, Jones, Zaccaria.

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the preschool and elementary school years, with emphasis on development as a process of social learning; interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. 1 unit. Prerequisite: Educational Psychology 311 and 312. Jones, Wolff.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. 1 unit. Prerequisite: Educational Psychology 311, 312, and 390. R. H. Simpson.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. Psycho-educational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis and use of test results and resource materials in this field. 1 unit. Prerequisite: A course in psychology; consent of instructor. R. H. Simpson.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. 1 unit. Prerequisite: Educational Psychology 311 and 312; Educational Psychology 411 or 412; candidacy for Ed.D. or Ph.D. in Education. Blair, Jones.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. 1 unit. Prerequisite: Educational Psychology 311 and 312. Boney, Brophy, Kaczkowski, Ohlsen, Proff, Shoemaker, Slater.

423. **The Use of Tests in Guidance.** Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. 1 unit. Prerequisite: Educational Psychology 390, 392, and 422, or equivalents. Brophy, Hastings, Patterson, Phillips, Proff.

424. **Supervised Practice in Counseling.** Study of the individual client through the use of the tools of the counselor. Each student is expected to develop professional skills by working with clients. 2 units. Prerequisite: Master's degree in guidance; consent of faculty committee. Staff.

425. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Educational Psychology 325 are not given credit for Educational Psychology 425. 1 unit. Staff.

427. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. 1 unit. Prerequisite: Educational Psychology 311, 312, 422, 423, and either 325 or 425; or consent of instructor. Boney, Kaczkowski, Ohlsen.

428. **The Analysis and Use of Occupational Information in Guidance Programs.** Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. 1 unit. Prerequisite: Educational Psychology 425 or an introductory course in counseling. Brophy, Kaczkowski, Ohlsen, Shoemaker, Zaccaria.

429. **Field Instruction in Counseling.** Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. 1 or 2 units. Prerequisite: Educational Psychology 422 and 424 (with consent of instructor, registration in Educational Psychology 424 may be concurrent). Staff.

447. **Seminar in Rehabilitation Counseling.** Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publications. May be repeated for a maximum of one unit. ½ unit. Prerequisite: Educational Psychology 326 and 422. Moses, Patterson.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. Staff.

490. **Seminar for Advanced Students of Education.** Seminar in educational psychology open only to persons who have been admitted for doctoral study in educational psychology. 1 to 2 units. Staff.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. Staff.

492. **Psychology of Learning and Instruction.** Same as Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. Anderson.

494. **Multivariate Analysis in Psychology and Education.** Same as Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multi-dimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. Tucker.

495. **Theory of Measurement.** Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307 or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. Stake, Tucker.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. 1 unit. Prerequisite: Educational Psychology 390. Pingry, Stake, Tatsuoka.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Analysis of variance and co-variance, experimental design, introduction to multivariate statistical techniques including discriminant analysis. 1 unit. Prerequisite: Educational Psychology 496. Tatsuoka.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evalua-

tion dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. 1 unit. Prerequisite: Educational Psychology 496. HASTINGS, SPENCER, STAKE.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understanding. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

312. **Mental Hygiene and the School.** An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

313. **Principles of Programed Instruction.** The design, production, and evaluation of self-instructional materials, including delineation of objectives, task analysis, frame writing, frame editing, pilot testing and revision, and field testing; survey of current research and orientations toward programed instruction; consideration of the mechanized and text forms for presenting programs. Each student prepares a self-instructional program. 1 unit. Prerequisite: Educational Psychology 311. ANDERSON.

325. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in schools; what the teacher can do in guidance. Students may not register for credit in both Educational Psychology 325 and 425. ½ unit. Prerequisite: Eight semester hours in education and psychology. BROPHY, KACZKOWSKI, PROFF.

326. **Introduction to Vocational Rehabilitation Counseling.** A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and problems of vocational rehabilitation counseling. ½ unit. Prerequisite: Consent of instructor. MOSES, PATTERSON.

339. **Corrective Reading.** Same as Elementary Education 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338. BENNETT.

343. **Individual Intelligence Testing.** The fundamental concepts relevant to the general problem of the individual testing of learning aptitude. Acquisition of psychometric competence in the use of the 1960 Binet and the Wechsler tests. Acquaintance and limited practice in the administration, scoring, and interpretation of results obtained by means of performance scales and other devices appropriate for use with individuals having sensory, associative, and/or motor impairments. 1 unit. Prerequisite: Six hours of psychology and Special Education 324 or Educational Psychology 392 or Psychology 290, or equivalent. NEWLAND, PHILLIPS.

360. **Educational Uses of Television and Radio.** Same as Communications and Radio-Television 360. A study of television and radio as educational instruments, and

standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. McIntyre, Skornia.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. The course includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. 1 unit. Aleamoni, Hastings, Pingry, Stake, Tatsuoka.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. Gronlund, Hastings, Spencer.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. Gronlund, Hastings, Spencer, Stake.

Elementary Education

COURSES FOR GRADUATES

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. 1 unit. Staff.

432. **Clinical Diagnosis and Remediation in Reading.** Supervised experience in the Reading Center; special attention is given to evaluative and interpretative techniques in cases of severe reading disabilities based on the analysis of specific reading needs. May be repeated for a maximum of 2 units of credit. 1 unit. Prerequisite: Elementary Education 339 and a course in individual mental testing.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the following fields: (a) language arts, (b) social studies, (c) arithmetic, (d) science, (e) creative arts, (f) reading, (g) early childhood education. 1 unit. Prerequisite: For all sections, Elementary Education 431 or 434; for the section in language arts, Elementary Education 333 and 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in creative arts, Elementary Education 337 or consent of instructor; for the section in science, Elementary Education 335 or a methods course in teaching science in the elementary school and two years of college science, or consent of instructor; for the section in reading, Elementary Education 336 or a course in teaching of reading; for the section in early childhood education, Elementary Education 434. Staff.

434. **Programs in Early Childhood Education.** An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. 1 unit. SPODEK.

436. **Field Instruction in Reading Programs.** Provides for directed practice in the area of reading; students are placed in an approved and supervised field position for part of the semester. 1 unit. Prerequisite: Elementary Education 432.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. 1 unit. Prerequisite: Educational Psychology 312 or consent of instructor.

438. **The Organization and Supervision of School Reading Programs.** Study of procedures for planning, improving, and evaluating reading programs on a system-wide basis. Open only to those persons who are preparing to supervise reading programs or with approval of graduate adviser. 1 unit. Prerequisite: Elementary Education 339 or Educational Psychology 339; Elementary Education 433.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. MCGILL, SHORES.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

455. **Theories of Art Education.** A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. 1 unit. Prerequisite: Elementary Education 337 or Secondary and Continuing Education 456, or consent of instructor. LANSING, R. A. SMITH.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of elementary education. 1 to 2 units. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in elementary education open only to persons who have been admitted for doctoral study in elementary education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

333. **The Teaching of Language Arts in the Elementary School.** Concerns itself with goals, content, and teaching problems involved in the devising of programs in the area of elementary school language arts that are cumulative and sequential from kindergarten through the elementary school. ½ to 1 unit. Prerequisite: Educational Psychology 236.

334. **Principles and Practices in Early Childhood Education.** A study of the practices and principles of using play as an educational tool in early childhood education; presents a review of historical, philosophical, and psychological foundations of nursery-kindergarten methods, assesses techniques relating play to various aspects of instruction, surveys materials and equipment, and presents methods of classroom evaluation. ½ unit. Prerequisite: Elementary Education 237.

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the classroom teacher and the specialist. Opportunity for experience in field and laboratory work. ½ unit. Prerequisite: Elementary Education 233 and 237, or equivalent; two years of college science. Atkin, R. W. Burnett, Shoresman.

336. **Primary Reading.** Basic principles, techniques, and materials for the developmental reading program in the primary grades. Emphasis is placed on methods and materials which provide for differentiated instruction. ½ or 1 unit. Prerequisite: Junior standing; registration in a teacher education curriculum. Bennett, Durkin, Moore, Powell, Shores.

337. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. ½ unit. Prerequisite: Junior standing. Lansing, Schultz, R. A. Smith.

338. **Teaching of Reading in Grades Four Through Twelve.** Same as Secondary and Continuing Education 338. Developmental reading programs beyond the primary grades. Factors related to reading speed and comprehension; vocabulary development, specific comprehension skills, study skills, reading interests and tastes. ½ or 1 unit. Prerequisite: Elementary Education 336 or Educational Psychology 211.

339. **Corrective Reading.** Same as Educational Psychology 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338.

354. **Audio-Visual Communication.** See Secondary and Continuing Education. 1 unit.

History and Philosophy of Education

COURSES FOR GRADUATES

400. **Problems of Educational Theory.** Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305. McMurray.

401. **Modern Theories of Education.** A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. 1 unit. Stanley.

402. **Educational Movements in the Twentieth Century.** A historical study of significant educational trends during the past sixty years, with special reference to their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. 1 unit. Prerequisite: History and Philosophy of Education 300, or 302, or 403, or consent of instructor. TYACK.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. 1 unit. Prerequisite: History and Philosophy of Education 300 or 302, or consent of instructor. TYACK.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. BROUDY.

405. **Foundations of Aesthetic Education.** A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas investigated. 1 unit. Prerequisite: Consent of instructor. BROUDY.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop an understanding of, and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. TYACK.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment and knowing, examined from the standpoint of recent developments in pragmatism. 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. **Advanced Philosophy of Education.** A systematic exploration of knowledge and inquiry as they relate to problems of formulating educational policy, curriculum design, organization of the school system, and teaching-learning. Selected materials in the history of epistemology are examined and emphasis is placed on a critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

409. **Advanced Philosophy of Education.** A study of the nature of value as it relates to problems of formulating and justifying educational aims and policies, curriculum design, organization of the school system, and teaching-learning. Selected materials in ethics, value theory, and aesthetics are used in the critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of

social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in education. BROUDY, J.R. BURNETT, B. O. SMITH, STANLEY.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

483. **Methods in Comparative Education.** Methodologies and concepts involved in comparative educational systems in selected countries; topics related to the role of normative, institutional, and environmental patterns in shaping educational policies related to administration, curriculum development, diversification and expansion of educational opportunity. 1 unit. Prerequisite: Anthropology 373, Sociology 300, History and Philosophy of Education 303, or consent of instructor.

490. **Seminar for Advanced Students of Education.** Seminar in history and philosophy of education open only to persons who have been admitted for doctoral study in history and philosophy of education. Sections are usually offered in the following fields: (a) history of education, (b) philosophy of education, (c) comparative education, (d) social foundations of education. 1 to 2 units. Prerequisite: History and Philosophy of Education 483. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **The History of Education.** Brief introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. ½ unit. TYACK.

301. **Philosophy of Education.** Based on Dewey's *Democracy and Education*, this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. ½ unit. J. R. BURNETT, MCMURRAY, STANLEY.

302. **History of American Education.** The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural enviornment upon evolving conceptions of educational theory and practice. ½ unit. TYACK.

303. **Comparative Education.** A study of selected national systems of education in their differing cultural settings. ½ unit. YATES.

304. **Social Foundations of Education.** An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. ½ unit. J. R. Burnett, B. O. Smith, Stanley.

305. **History of Educational Ideas.** Through a study of selected educational theorists and intellectual movements, this course provides familiarity with the major educational ideas of the past, as well as historical perspectives on current issues and problems in education. Readings in Plato, Quintilian, St. Augustine, Loyola, Comenius, Rousseau, Pestalozzi, Froebel, Herbart, Dewey, and others. ½ unit. McMurray.

315. **Sociology of Education.** Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

Secondary and Continuing Education

COURSES FOR GRADUATES

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. Staff.

441. **Linguistic and Logical Analysis of Teaching.** An analysis of teaching from the standpoint of semantic and logical factors. Topics such as theories of meaning, definition, explanation, and justification as employed by a teacher are discussed. 1 unit. K. B. Henderson.

448. **Continuing Education.** Development, status, and prospects of continuing education for adults. Institutions, agencies, and programs; public policy and policy-making for continuing education; organization, administration, finance, and promotion; recruiting, training, and supervising staff; planning programs and courses; the literature of continuing education. Systematic study of individual problems supplements class work. ½ or 1 unit. Phipps.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. Staff.

456. **Problems and Trends in Specialized Fields of Secondary Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. 1 unit. Sections are usually offered in the following fields:

(a) **English.** DeBoer, Erickson, Madsen, Walker.
(b) **Foreign Languages.** Daigh, Kaulfers, Kettelkamp.
(c) **Mathematics.** K. B. Henderson, Pingry, Travers.
(d) **Science.** R. W. Burnett, Gould, Shoresman, Weller.
(e) **Social Science.** Cox, Metcalf.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of secondary and continuing education. 1 to 2 units. STAFF.

467. **The American College.** Development of the American college and university; higher education processes, organization, and administration; the variety of problems and conflicting theories; policies, practices, and present trends. 1 unit. EPPERSON, FLEY.

490. **Seminar for Advanced Students of Education.** Seminar in secondary and continuing education open only to persons who have been admitted for doctoral study in secondary and continuing education. 1 to 2 units. METCALF.

491. **Field Study and Thesis Seminar.** The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

338. **Teaching of Reading in Grades Four Through Twelve.** Same as Elementary Education 338. Developmental reading programs beyond the primary grades. Factors related to reading speed and comprehension; vocabulary development, specific comprehension skills, study skills, reading interests and tastes. ½ or 1 unit. Prerequisite: Elementary Education 336 or Educational Psychology 211.

354. **Audio-Visual Communication.** Same as Elementary Education 354. An analysis and application of those introductory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit.

Special Education

COURSES FOR GRADUATES

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis, and social, medcal, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, and anthropology, and psychology to educational theory and practice with reference to the mentally deficient. 1 unit. Prerequisite: Special Education 322 or consent of instructor. R. A. HENDERSON, S. A. KIRK.

417. **Psycho-Educational Problems of Exceptional Children.** A course for educators, students in the behavioral sciences, and students beginning graduate study in special education. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children and consideration of major current problems in the development of educational programs. 1 unit. Prerequisite: Sixteen hours of psychology and/or education or consent of instructor. BEREITER, R. A. HENDERSON, QUIGLEY.

418. **Communicative Problems of the Deaf.** An advanced course in the problems of the deaf in communication, including the learning of language, reading, speech,

speech reading, and research in these areas. Consideration is given to the various methods that are used in the teaching of these basic skills to deaf children and to the social and psychological principles underlying the methods. 1 unit. Prerequisite: Consent of instructor. QUIGLEY.

419. **Diagnosis of Learning Disabilities.** A clinical course in the diagnosis of learning disorders in children with particular emphasis on psycholinguistic and reading disabilities. The course includes study of the genetic, neurophysiological, and psychological theories and constructs relating to learning disorders, and provides laboratory practice in the diagnosis of children with learning disorders. 1 unit. Prerequisite: Psychology 433 or Educational Psychology 343. CHALFANT, S. A. KIRK.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, and of the somato-psychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. Implications for current educational programs for the handicapped are analyzed. 1 unit. Prerequisite: Special Education 117 or 417 and Educational Psychology 312, or consent of instructor. FARBER, GALLAGHER, NEWLAND.

421. **Administration and Supervision of Special Education.** Designed for advanced graduate students preparing for administrative or supervisory positions in special education programs. Administrative and supervisory practices in educating exceptional children are examined with emphasis on special education programs in the public schools; application of administrative theory to special education programs. Field trips to observe and evaluate programs are required. 1 unit. Prerequisite: Special Education 417; Educational Administration and Supervision 460; consent of instructor. CHALFANT, R. A. HENDERSON, M. B. KARNES, ROBBINS.

444. **Practicum in Remediation of Learning Disabilities.** A clinical course in the remediation of learning disabilities in children. The course includes a study of remedial philosophies, the relationships between diagnosis and remediation, specific remedial techniques, and their applicability to certain learning disorders, and provides supervised clinical practice in planning, executing, and reporting remedial programs. 1 unit. Prerequisite; Special Education 419. CHALFANT, S. A. KIRK, WISEMAN.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

456. **Problems and Trends in Special Education.** Introduces the student to significant problems, points of view, and trends in the field concerned. Significant research related to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, and (g) culturally disadvantaged children. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of special education. 1 to 2 units. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in the education of exceptional children open only to persons who have been admitted for doctoral study in special education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. **The Gifted Child in School and Society.** A consideration of the gifted in society: who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. ½ to 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GALLAGHER, ROGGE.

317. **Psycho-Social Educational Aspects of Deafness.** Historical and current societal perceptions of the deaf; analysis of the various effects and patterns of auditory impairment on children and adults; intelligence, personal and social adjustment, the psychological processes, and how they affect the acquisition of language, speech, speech reading, reading, and writing, ½ to 1 unit. Prerequisite: Special Education 117 and Psychology 100 or Educational Psychology 211. QUIGLEY.

318. **Workshop and Laboratory in Education of Exceptional Children.** For those specializing in exceptional children. The following sections may be offered: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

319. **Special Education of the Deaf, I.** Survey of the curriculum and techniques in preschools, kindergarten, primary, and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child; study of sense training, lip reading, vocabulary development, reading techniques, elementary school subjects, language and speech development, auditory training, and curriculum construction. 1 to 1½ units. Prerequisite, Consent of instructor. SCHMITT.

320. **Special Education of the Deaf, II.** Continuation of Special Education 319. 1 to 2 units. Prerequisite: Special Education 319. SCHMITT.

321. **Education of Disturbed and Conduct-Problem Children.** A study of the social, emotional, and learning characteristics of children who are disturbed or who exhibit problems of conduct; methods of diagnosis and differentiation; educational environments and teaching methods used for their remediation. ½ to 1 unit. Prerequisite: Special Education 117 or equivalent; Elementary Education 236 or equivalent. BRENTRO.

322. **Psychology and Education of the Mentally Handicapped, I.** A study of the social, emotional, physical, and learning characteristics of mentally handicapped children; methods of diagnosis and differentiation; curriculum and teaching techniques employed for their education. ½ unit. Prerequisite: Elementary Education 231. CLARK, JORDAN.

323. **Psychology and Education of the Mentally Handicapped, II.** Continuation of Special Education 322, with emphasis on curriculum. ½ unit. Prerequisite: Special Education 322. CLARK, JORDAN.

324. **Mental and Educational Measurement of Exceptional Children.** Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech defective. ½ or 1 unit. Prerequisite: Special Education 117 or consent of instructor. HURLEY.

Vocational and Technical Education

COURSES FOR GRADUATES

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. 1 unit. EPPERSON.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. 1 unit. MATHER, E. SIMPSON, SPITZE.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. 1 unit. MATHER.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. 1 unit. E. SIMPSON.

456. **Problems and Trends in Specialized Fields of Vocational and Technical Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections are usually offered in the following fields: (a) agricultural education, (b) business education, (c) home economics education, (d) industrial education. 1 unit. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of agriculture, business, home economics, and industry. ½ or 1 to 2 units. STAFF.

471. **Policy and Program Development for Education in Agriculture.** Local, state, and national policies for agricultural education; organizing for policy-making; developing desirable policies and programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. Open to school administrators and extension educators without prerequisite. PHIPPS.

472. **Course Planning and Teaching Procedures in Vocational Agriculture.** Gathering data essential in course planning, constructing course plans, developing

resource units, teaching procedures, and instructional aids. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. Fuller, Hemp.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. Hemp.

474. **Supervised Agriculture Experience in Vocational Agriculture.** Supervised agricultural experience programs as an educational strategy; importance and meaning of supervised agriculture experiences; planning, conducting, supervising, and evaluating agriculture experience programs; relation of supervised agriculture experience programs to establishment and advancement in an occupation; keeping and using records; relating class instruction to supervised agriculture experience programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. Phipps, Warmbrod.

475. **Organizing and Teaching Agriculture Mechanics.** Agriculture mechanics as a phase of vocational education in agriculture: purposes, course planning for high school students, young farmers, and adults; methods of teaching and evaluating on-farm or on-job instruction; planning agriculture-mechanics shops and facilities; providing and teaching safety in agriculture mechanics. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. Phipps.

476. **Guidance in Agricultural Education.** The guidance function in young farmers' and adult farmers' classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment, placement, follow-up. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor.

481. **History and Basic Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. 1 unit. Campbell.

482. **Research Studies in Vocational and Technical Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research project, or plans in detail a major research project to be completed later. 1 unit. R. Evans, Phipps, E. Simpson.

487. **Seminar in Vocational, Technical, and Practical Arts Education.** Overview and interpretation of social, economic, and technological trends which have relevance to the problem of developing new programs in the vocational, technical, and practical arts areas; analysis and evaluation of innovations in the field; current issues and problems. 1 unit. Prerequisite: Graduate standing in vocational and technical education. M. R. Karnes, Phipps, E. Simpson.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses; study of basic concepts underlying course construction in industrial education. 1 unit. Prerequisite: Undergraduate work in appropriate vocational and technical education courses. Campbell, Tomlinson.

489. **Administration and Supervision of Vocational and Technical Education.** Problems and approved practices in the administration and supervision of programs of vocational, technical, and practical arts education in secondary schools, junior colleges, and technical institutes. 1 unit. Prerequisite: Consent of instructor. M. R. KARNES, TOMLINSON.

490. **Seminar for Advanced Students of Education.** Seminar in vocational and technical education open only to persons who have been admitted for doctoral study in vocational and technical education. Sections of this seminar are usually offered in the following areas: (a) industrial education, (b) agricultural education, and (c) home economics education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructors to schools in which first-year teachers are employed. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. FULLER, WARMBROD.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. ½ or 1 unit. TOMLINSON.

382. **Cooperative Vocational and Technical Education Programs.** This course is designed to provide the specific professional background required of teachers, coordinators, and administrators who organize and conduct public school programs utilizing community resources and experiences. The course includes the background, philosophy, organization, and administration of cooperative education. ½ or 1 unit. TOMLINSON.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. ½ or 1 unit. TOMLINSON.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. 1 unit. Prerequisite: Sixteen hours in appropriate vocational and technical education courses. TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, and their relationships to other educational agencies. 1 unit.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Ten hours of undergraduate credit in appropriate vocational and technical education courses. CAMPBELL, TOMLINSON.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the Master of Science and Doctor of Philosophy is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. To be admitted, an applicant must have the equivalent of a grade-point average of 4.0 or B for the last sixty semester hours of undergraduate study. Courses for advanced undergraduates and graduates are also open for credit to qualified students majoring in other fields.

A minimum of eight units must be completed for the master's degree, including a thesis. At least four units must be at the 400 level, including a course in circuit theory and one in field theory. In addition, graduate or undergraduate credit in a modern physics course is required.

All students desiring to enter the doctoral program must take the electrical engineering qualifying examination. Students who earn the master's degree at the University of Illinois take the examination during the term they earn their eighth unit of graduate credit. Students who enter with the master's degree must take the examination during their first term here.

Eight units of course credit beyond the master's degree, or the equivalent, plus eight units of thesis research and a satisfactory thesis, are minimum requirements for the Doctor of Philosophy. In addition, the candidate must demonstrate reading proficiency in two of the following languages: French, German, Russian. He also must have completed two courses in modern physics. In his course program he must offer a major and either one or two minors. A single minor requires four units in one field outside the major field, at least one of which must be at the 400 level. If two minors are chosen, each must consist of at least two units. Advanced courses in mathematics, physics, physiology, chemistry, nuclear engineering, and other branches of engineering are recommended minors.

Further details may be found in the *Electrical Engineering Graduate Study Manual*, available from the department.

GRADUATE FACULTY

Professors: E. C. Jordan (Head of Department), H. W. Ades, F. Adler, G. E. Anner, W. R. Ashby, D. S. Babb, A. D. Bailey, J. Bardeen, S. A. Bowhill, R. M. Brown, R. T. Chien, P. D. Coleman, J. B. Cruz, G. A. Deschamps, F. Dunn, J. D. Dyson, W. L. Emery, W. L. Everitt, G. H. Fett, W. J. Fry, L. Goldstein, P. Handler, H. N. Hayward, M. S. Helm, C. D. Hendricks, F. E. Hohn, N. Holonyak, D. F. Holshouser, B. C. Kuo, Y. T. Lo, W. Mayeda, P. E. Mayes, M. S. McVay, W. E. Miller (Associate Head of Department), R. Mittra, D. E. Muller, S. Muroga, G. R. Peirce, D. Pines, W. J. Poppelbaum, J. E. Robertson, C. T. Sah, P. F. Schwarzlose, M. D. Sirkis, G. W. Swenson, H. M. Von Foerster, N. Wax, H. D. Webb.

Associate Professors: W. G. Albright, R. B. Ash, D. L. Bitzer, R. W. Burtness, J. H. Cahn, D. H. Cooper, M. H. Crothers, P. R. Egbert, E. W. Ernst, F. J. Fry, O. L. Gaddy, D. F. Hang, E. C. Hayden, J. O. Kopplin, G. H. Leichner, P. E. Mast, T. A. Murrell, J. P. Neal, W. R. Perkins, G. A. Metze, S. R. Ray, J. T. Verdeyen, K. C. Yeh.

Assistant Professors: J. R. Baird, M. L. Babcock, J. W. Beauchamp, B. E. Cheerington, P. W. Klock, N. Narayana Rao, C. F. Sechrist, B. G. Streetman, T. N. Trick.

COURSES FOR GRADUATES

400. **Seminar.** Required of all graduate students. No credit.

412. **Advanced Engineering Measurements.** Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. 1 unit.

414. **Engineering Applications of Linear Graphs.** Same as Computer Science 414. Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 315 or 318.

415. **Control System Theory and Design.** Synthesis of feedback control systems to meet design specifications, including sensitivity; multivariable systems; introduction to systems with random inputs; state variable techniques; nonlinear systems. 1 unit. Prerequisite: Electrical Engineering 386 or equivalent, or consent of instructor.

416. **Analysis of Networks and Systems.** Dynamic equations of linear lumped networks and systems; time-domain analysis and state space methods; frequency-domain analysis and transform methods; stability criteria. Applications to various problems in electrical engineering. 1 unit. Prerequisite: Credit or registration in Mathematics 346 or 348; Electrical Engineering 322.

418. **Electric and Magnetic Fields.** Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. 1 unit.

420. **Electromagnetic Waves and Radiating Systems.** Fundamental electromagnetic theory with applications to transmission lines, waveguides, and antennas; introduction to the solution of advanced problems in static electric and magnetic fields. 1 unit. Prerequisite: Electrical Engineering 352.

421. **Advanced Electromagnetic Engineering.** Reciprocity and equivalence principles; formulation of scattering and diffraction problems; approximations for large and for short wavelengths; plane cylindrical, and spherical wave problems; variational methods; Wiener-Hopf techniques; applications to antennas and waveguide problems. 1 unit. Prerequisite: Electrical Engineering 420.

423. **Gaseous Electronics and Plasmas.** Irreversible thermodynamics; transport theory; magnetohydrodynamics; collective behavior. 1 unit. Prerequisite: Physics 362 and Electrical Engineering 420, or equivalent.

425. **Quantitative Neuroanatomy Lecture.** Same as Physiology 425. A detailed consideration of (1) quantitative methods of studying structure in the central nervous system, (2) analysis of quantitative data concerning cell and fiber populations and related characteristics in both normal and modified brains, and (3) derivation of neuronal circuitry. 1 unit. Prerequsite: Physiology 416 or equivalent; consent of instructor.

426. **Quantitative Neuronanatomy Laboratory.** Same as Physiology 426. Practice in the use of quantitative methods for precisely determining nerve cell populations and other components of the central nervous system and in measuring properties of subcellular components of anatomic significance. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor.

427. **Boundary Value Problems.** Derivation and solution of partial differential equations and integral equations of mechanics and electricity and magnetism; study of the analysis of wave motions. 1 unit.

428. **Analysis of Nonlinear Systems.** Same as Theoretical and Applied Mechanics 428. Singular points and stability considerations are treated. Graphical and analytical

methods, including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations, are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor.

429. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedback circuits and amplifiers, stability, equalizers, and relations between components of network functions. 1 unit.

431. **Theory of Guided Waves.** Propagation in general cylindrical waveguides; Eigenvalue problems; stationary principles; microwave circuit theorems, boundary value problems, and the determination of circuit parameters; periodically loaded waveguides with anisotropic media. 1 unit. Prerequisite: Electrical Engineering 420.

434. **Random Processes in Electrical Engineering.** Survey of measure theoretic probability theory; analysis of second order random processes, including the spectral theory and harmonic analysis; transmission of noise through linear and nonlinear systems; the signal detection problem. 1 unit. Prerequisite: Mathematics 361.

435. **Theory of Semiconductors and Semiconductor Devices.** Same as Physics 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

437. **Principles of Microwave Measurements.** Generation and detection of the laboratory signal; the generalized impedance concept; matrix representation of waveguide discontinuities; determination of equivalent network parameters; analysis of measurement techniques by signal flow graphs; accuracy criteria. 1 unit. Prerequisites: Electrical Engineering 355 and 356.

438. **Stochastic Processes in Engineering.** Same as Aeronautical and Astronautical Engineering 453. Supplementing Aeronautical and Astronautical Engineering 452 or Electrical Engineering 434 for additional engineering applications of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or equivalent.

439. **Advanced Theory of Semiconductors and Semiconductor Devices.** Continuation of Electrical Engineering and Physics 435. Selected advanced topics of current interest in the physics of semiconductors and solid state devices. 1 unit. Prerequisite: Electrical Engineering and Physics 435.

440. **Advanced Power Circuit Analysis, I.** Analysis of power systems by symmetrical and related components; equivalent circuits of lines, transformers, and machines; fault calculations on symmetrical and unsymmetrical power systems; the network analyzer in fault studies. 1 unit.

445. **Power System Stability.** Transient and steady-state stability in power systems; power flow equations; transient stability swing curves; critical clearing time; the network analyzer in stability studies; the analog computer in transient stability studies. 1 unit. Prerequisite: Electrical Engineering 440.

451. **Advanced Network Synthesis.** Characterization of N-ports; the scattering matrix; indefinite admittance matrix; broadband matching; N-port synthesis techniques; active network synthesis; sensitivity of networks. 1 unit. Prerequisite: Electrical Engineering 324; credit or registration in Mathematics 346 and Electrical Engineering 416.

452. **Time-Varying and Nonlinear Circuits.** Energy considerations; equations in normal form; frequency power relations in nonlinear networks; frequency conversion; Lyapunov's direct method; the circle stability criterion; calculus of variations and Hamilton's principle applied to the stability and matching problems 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 345.

453. **Optimum Control Systems.** Formulation of the optimization problem; controllability; observability; stability; Lyapunov's second method; application of variational calculus, maximum principle and principle of optimality to control problems; stochastic control; adaptive control. 1 unit. Prerequisite: Electrical Engineering 415.

454. **Sampled-Data Control Systems.** Analysis and design of feedback control systems with digital and sampled data. 1 unit. Prerequisite: Electrical Engineering 386 or 415, or equivalent.

456. **Coding Theory.** Same as Computer Science 456. General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data-transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

463. **Information Theory.** Same as Computer Science and Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or Electrical Engineering 433.

465. **Topics in Automata Theory.** Same as Computer Science and Mathematics 465. Topics selected from mathematical systems and automata theory, decision problems, formal languages, decomposition theory, etc. 1 unit. Prerequisite: Mathematics 392 or consent of instructor.

467. **Atomic Collision Processes.** Same as Physics 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photoprocesses and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

472. **Quantum Electronics.** A brief theoretical introduction to quantum mechanics and atomic physics, with many applications in spin resonance and modern maser theory. 1 unit. Prerequisite: Physics 381. It is recommended that Physics 362 and 385 be taken before registering in this course.

473. **Fundamentals of Cybernetics.** Same as Biophysics and Communications 435. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering or Computer Science 394 or Mathematics 361, or consent of instructor.

474. **Problems of Cybernetics.** Same as Biophysics and Communications 436. A continuation of Electrical Engineering 473. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Electrical Engineering 473.

475. **Ionospheric Radio Propagation.** Propagation in a stratified medium; WKB solution; ray theory; ionospheric sounding; ionospheric transmission problems; scattering by irregularities; propagation in a random medium; cross-modulation and nonlinear effects; magneto-ionic theory; Faraday effect; whistler propagation; coupling of characteristic waves; magneto-hydrodynamic waves; formation

of ionospheric E-region; formation of F-region. 1 unit. Prerequisite: Electrical Engineering 420 or equivalent.

481. **Threshold Logic.** Same as Computer Science 481. Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. **Theory of Digital Computer Arithmetic.** Same as Computer Science 482. This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Computer Science or Electrical Engineering 394.

485. **Advanced Theory of Magnetic and Optic Computer Memory Devices.** Same as Computer Science 485. Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media: modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Electrical Engineering or Computer Science 385.

486. **Constitution of the Ionosphere: An Introduction to Aeronomy.** Same as Astronomy 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ions of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent.

490. **Seminar in Special Topics.** Lectures and discussions on current research and literature on advanced topics in electrical engineering. Course may be repeated. 0 to ½ unit. Prerequisite: Advanced standing; consent of instructor.

497. **Electrical Engineering Problems.** Lectures and discussions relating to new areas of interest. 0 to 1 unit. May be repeated. Prerequisite: Consent of instructor.

498. **Individual Study.** Individual projects. ½ to 2 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

322. **Linear Network Theory, II.** Signal representation in terms of Fourier series, Fourier transforms, and Laplace transforms; role of exponential and sinusoidal signals in system analysis for arbitrary waveforms; two-ports and filters as signal processors. 0 to 1 unit. Prerequisite: Electrical Engineering 250 and 251; Computer Science 101; Mathematics 345.

323. **Circuit Laboratory.** To accompany Electrical Engineering 322 and 350. 0 or ¼ unit. Prerequisite: Electrical Engineering 251 and 322; credit or registration in Electrical Engineering 350.

324. **Introduction to Network Synthesis.** An introduction to modern methods of network synthesis; properties of driving-point and transfer functions; approximation and scaling; LC, RC, and RLC synthesis methods; ladder n work development; and resistively terminated coupling networks. 0 to 1 unit. Pı equisite: Electrical Engineering 322.

330. **Magnetic Circuits and Transformers.** Magnetic circuit analysis; transformer theory; special magnetic circuit applications. 0 to ¾ unit. Prerequisite: Electrical Engineering 229, 250, and 251; credit or registration in Electrical Engineering 331.

331. **Magnetic Circuits and Transformers Laboratory.** To accompany Electrical Engineering 330. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330.

332. **Electrical Machinery.** Induction machines; single-phase motors; direct-current machines; application. 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. **Electrical Machinery Laboratory.** To accompany Electrical Enginnering 332. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

336. **Advanced Analysis of Electric Power Equipment.** Transformers, synchronous and induction machines; power machines in systems; single phase motors; extension of the two-reaction analysis to the general machine. 0 or 1 unit. Prerequisite: Electrical Engineering 330 and 331.

340. **Electronics.** Emission, electron ballistics, high vacuum electron tubes, semiconductors and transistors, tube and transistor characteristics and equivalent circuits, gaseous conduction and gas tubes, introduction to methods of analysis. 0 to ¾ unit. Prerequisite: Electrical Engineering 250 and 251.

341. **Electronics Experimentation.** Problems of experimentation and measurement with electronic circuits and devices. Lecture and laboratory. 0 or ¼ unit. Prerequisite: Electrical Engineering 251; credit or registration in Electrical Engineering 340.

342. **Advanced Electronics.** Linear and nonlinear amplification; modulation and demodulation concepts; introduction to feedback amplifiers and oscillators. 0 to ¾ unit. Prerequisite: Electrical Engineering 322, 340, and 341.

343. **Electronics Laboratory.** 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 342.

347. **Industrial Electronics.** Electronic circuits for automatic control and measurement systems with applications. 0 to 1 unit. Prerequisite: Electrical Engineering 322, 330, and 342. Credit toward graduation is not given for both Electrical Engineering 347 and 381.

349. **Electron Tube Circuits.** Linear and nonlinear amplifiers, fundamentals of modulation and detection, oscillators, rectifiers. 0 or 1 unit. Prerequisite: Electrical Engineering 342.

350. **Lines, Fields, and Waves.** Transmission lines, field calculations, and wave propagation. ¾ unit. Prerequisite: Electrical Engineering 229; Computer Science 101; credit or registration in Electrical Engineering 323.

352. **Electromagnetic Fields.** Uniform plane waves, wave guides, radiation and propagation of electromagnetic energy, radiating systems, and electrodynamics. ¾ unit. Prerequisite: Electrical Engineering 350 and 323; concurrent registration in Electrical Engineering 356 is recommended.

353. **Radio Circuits.** Component behavior at communication frequencies, impedance transforming networks for single and multiple frequencies; low-level tuned and compensated amplifiers, broad band impedance matching; equalizers. 0 or 1 unit. Prerequisite: Electrical Engineering 322 and 340.

355. **Fields and Waves.** Electromagnetic fields; wave guides; radiation and propagation of electromagnetic energy; radiating systems. 0 or ¾ unit. Prerequisite: Electrical Engineering 229 and 350, or consent of instructor.

356. **Microwave Techniques.** UHF and microwave sources and detectors; laboratory techniques for UHF and microwave frequencies. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 352 or 355.

357. **Radio Astronomy.** Same as Astronomy 357. Instrumental theory and observational techniques; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108.

359. **Introduction to Noise and Information Transmission.** Signals and their spectra; methods of communication systems analysis; modulation by AM, FM, PAM, PPM; origin of noise, properties of noise, introduction to probability theory, system comparison using statistical approach. ¾ or 1 unit. Prerequisite: Electrical Engineering 322; credit or registration in Electrical Engineering 342.

366. **Aeronomy: Physics of Upper Atmosphere and Space.** Same as Astronomy and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetrary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

376. **Symmetrical Component Analysis of Power Systems.** Representation of power systems; symmetrical components, positive, negative and zero sequence impedances of network components, sequence networks; unsymmetrical faults, unsymmetrical power systems, matrix algebra in symmetrical component analysis. 0 or 1 unit. Prerequisite: Electrical Engineering 350.

378. **Electric Power Networks.** Steady-state power network analysis; inductive coordination; transmission line capacitance and resistance; networks synthesis; application of computers to power network problems. 0 or 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

381. **Pulse Techniques.** An introduction to the response of electrical networks to nonsinusoidal inputs, the analysis of active circuits with large signals, and the circuits and techniques used in pulse and digital equipment. Credit toward graduation is not given for both Electrical Engineering 381 and 347. 0 or 1 unit. Prerequisite: Electrical Engineering 322, 340 and 341, or consent of instructor.

382. **Transistor Circuits.** This course is the same as Electrical Engineering 383 but has one three-hour laboratory added each week. 1 unit. Prerequisite: Electrical Engineering 342, credit or registration in Metallurgical Engineering 384, or consent of instructor.

383. **Transistor Circuits.** Junction transistors, diodes, and related semiconductor devices. Emphasis equally divided between device properties as related to semiconductor physics and circuit properties. Small signal theory of amplifiers and oscillators, large signal theory of power stages and switching circuits, negative resistance effects, high frequency limitations. ¾ unit. Prerequisite: Electrical Engineering 342, credit or registration in Metallurgical Engineering 384, or consent of instructor.

385. **Theory of Semiconductor Computer Devices.** Same as Computer Science 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization, and noise theory; integrated circuits technology: masking, oxidizing, and etching; emphasis on device-theoretical background for computer logic design. ¾ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. 0 or 1 unit. Prerequisite: Consent of instructor.

387. **Introduction to Quantum Electronics for Electrical Engineers.** Application of quantum mechanical concepts to electronics problems; for example: the genera-

tion and detection of coherent radiation, tunneling effects, and bulk oscillations in semiconductors. 1 unit. Prerequisite: Physics 383.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. 0 or 1 unit. Prerequisite: Electrical Engineering 340, 341, and Mathematics 345, or consent of instructor.

389. **Communication Design.** Over-all communication design problems; kinds of propagation; noise and interference; antenna temperature; transmitter power requirements; frequency selection; design of a portion of a receiver, transmitter, or antenna. 0 or ¾ unit. Prerequisite: Electrical Engineering 342 and 350.

391. **Boolean Algebra and Switching Theory.** Same as Computer Science and Mathematics 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. ½ or 1 unit. Prerequisite: Consent of instructor.

392. **Introduction to Automata Theory.** Same as Computer Science and Mathematics 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 391, or consent of instructor.

393. **Digital Computer Circuit Design.** Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 294 or 391; credit or registration in Electrical Engineering 382 or 383, or consent of instructor.

394. **Logical Design of Automatic Digital Computer Circuits.** Same as Computer Science 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Electrical Engineering 294 or consent of instructor.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric and Composition)

Students who wish to be considered for admission to graduate work in English must have attained a grade-point average of at least 4.0. However, students whose averages are between 3.75 and 4.0 are considered on an individual basis. All students must present the equivalent of at least twenty hours of undergraduate work in English or American literature, although students with at least fourteen hours may be considered on an individual basis and granted probational entrance. This does not include required college work in rhetoric.

Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates must take English 446 and are required to choose at least three of their courses from those at the 300 level and three from those at the 400 level. Candidates must complete two courses in each of three areas of study as recognized by the department and must demonstrate proficiency in one language chosen from French, German, or Russian.

Candidates must also pass a final examination. A master's thesis is not required, but each candidate must deposit one term paper with the department.

Master of Arts in the Teaching of English. Candidates must earn at least four units in English, at least two of them in courses at the 400 level, and they must take the final examination for master's candidates in English. They must also deposit one term paper with the department. Candidates must also have had the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, Russian, or Spanish.

Specific requirements are divided into two programs, the first for those who have the Bachelor of Arts in English and the teacher's certificate, and the second for those who have the Bachelor of Arts in English but not the teacher's certicate. See pages 41 and 42.

For those with the certificate, the requirements are English, four units, including English 446 and at least one course above the 450 level; education, two units as follows: one unit in Educational Psychology 311 and 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high school teachers of English, as follows: one unit of either Secondary and Continuing Education 456 or English 447; one-half to three-quarters unit of either English 387 or Rhetoric 480; electives as needed to total at least eight units.

For those without the certificate, the requirements are English, four units, including English 446 and at least one course above the 450 level; education, two units as follows: one-half unit in Educational Psychology 311, one-half unit in Educational Psychology 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high school teachers of English, one-half to three-quarters unit in either English 387 or Rhetoric 480; electives, one-half to one unit as needed to total eight units. In addition to these courses, the candidates must take, without graduate credit, Secondary and Continuing Education 241 and 242. This program is designed to permit candidates to complete their work and qualify for a certificate and master's degree in two semesters and a summer. Those who lack certain prerequisites, such as general psychology, may need a little more time.

Electives may be in English, in education, or in exceptional cases, in other subjects.

Master of Arts in the Teaching of English as a Second Language. Detailed information concerning the curriculum and requirements for this degree should be requested from Professor Katharine O. Aston, Director of Programs in English as a Second Language, 317 English Building.

Doctor of Philosophy in English. In addition to satisfying the general requirements of the Graduate College, candidates must take at least two units of work in problems courses—those courses numbered 450 and higher. The department recommends that all work be taken at the 400 level.

English 445 and 446. All entering graduate students are required to take English 446, Introduction to Advanced Graduate Study. Candidates for the doctorate are required, in addition, to take English 445 during their first academic year in residence.

Proficiency Examination. Graduate students entering the doctoral program after taking degrees at other institutions are required to take a proficiency examination early in their first semester—or summer session—of residence.

Foreign Languages. Each student must demonstrate proficiency in two languages chosen from French, German, or Russian; but, with the approval of the adviser and the head of the department, he may petition the Dean of the Graduate College to be allowed to substitute Latin or Greek for one of these languages.

Minor Subjects. Students may offer a double minor, which includes English philology and one other subject, or a sole minor in English philology.

Preliminary Examination. This examination is given in October, January, and April of each year. It consists of two parts, a written examination and an oral examination.

Thesis. The student must submit a statement of his thesis plan, outlining its main topics, to the adviser within a reasonable period—usually six months—after he passes his preliminary examination.

More detailed information may be obtained by requesting a mimeographed state-

ment, "Graduate Studies in English," from the Director of Graduate Students, Department of English, 100 English Building.

GRADUATE FACULTY

Professors: A. L. Altenbernd (Head of Department), A. E. Barker, L. E. Berry, J. J. Campbell, E. H. Davidson, J. T. Flanagan, R. A. Gettmann, R. H. Green, R. L. Haig, A. G. Holaday, J. N. Hook, W. H. McBurney, B. A. Milligan, R. W. Rogers, C. H. Shattuck, D. A. Smalley, J. R. Squire, J. Stillinger, H. W. Wilson.

Associate Professors: Katharine O. Aston, R. L. Fumento, G. P. Haskell, R. J. Loftus, J. F. Lynen, S. Millet, F. B. Moake, R. L. Schneider, A. L. Scott, G. Scouffas, G. B. Stillwell, Priscilla Tyler, B. F. Wilkie.

Assistant Professors: R. R. Allen, E. J. Brandabur, H. C. Cole, W. M. Curtin, F. E. Hodgins, U. M. Kaufmann, J. B. Trahern, R. H. Wasson, G. G. Wright.

English Literature and American Literature

COURSES FOR GRADUATES

401. **Old English: Anglo-Saxon.** An introduction to the language before 1000 A.D. 1 unit.

402. **Old English: Beowulf.** 1 unit. Prerequisite: English 401.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. 1 unit.

404. **Old English Literature and Its Cultural Background.** An intensive, critical examination of Old English prose and poetry exclusive of Beowulf. The texts studied vary from year to year, but particular attention is given to such important bodies of writing as the Elegies, the *Anglo-Saxon Chronicle*, and the works of Cynewulf, Aelfric, Alfred, and Wulfstan. 1 unit. Prerequisite: English 401 and 402.

405. **Middle English.** Introduction to Middle English dialects, with special emphasis on the East Midland. 1 unit. Offered in 1968-1969 and in alternate years.

406. **Middle English Literature and Its Cultural Background.** English literature from 1100 to 1500 (excluding Chaucer), with emphasis on chronicle, romance, debate, lyric, and such major poems as *Pearl*, *Sir Gawain and the Green Knight*, and *Piers Plowman;* historical, social, and religious backgrounds. 1 unit.

407. **Studies in Chaucer and His Times, I.** A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. 1 unit.

408. **Studies in Chaucer and His Times, II.** Continuation of English 407. 1 unit.

411. **Studies in Sixteenth-Century Literature, I.** 1 unit. Milligan.

412. **Studies in Sixteenth-Century Literature, II.** Continuation of English 411. 1 unit. Milligan.

413. **Studies in Shakespeare.** 1 unit.

414. **Studies in Elizabethan Drama.** 1 unit.

416. **Studies in Late Renaissance Thought and Literary Theory.** The development of cultural ideas—religious, social, educational—in representative prose writers of the late sixteenth century and of the seventeenth century (Hooker, Bacon, Burton, Browne, Milton, Dryden, and others) in relation to literary theory and practice. 1 unit. Barker.

417. **Studies in Seventeenth-Century Poetry and Milton (1600-1640).** 1 unit. Barker.

418. **Studies in Seventeenth-Century Poetry and Milton (1640-1700).** Continuation of English 417. 1 unit. Prerequisite: English 417. Barker.

421. **Studies in Eighteenth-Century Literature, I.** 1 unit.

422. **Studies in Eighteenth-Century Literature, II.** Continuation of English 421. 1 unit.

423. **Studies in the Eighteenth-Century Novel.** 1 unit. McBurney.

427. **Studies in the Romantic Movement, I.** 1 unit. Gettmann.

428. **Studies in the Romantic Movement, II.** Continuation of English 427. 1 unit. Gettmann.

431. **Studies in Victorian Literature, I.** 1 unit. Smalley.

432. **Studies in Victorian Literature, II.** Continuation of English 431. 1 unit. Smalley.

433. **Major Movements in Modern British Poetry and Drama.** A study of important movements, figures, and ideas which shaped the criticism and practice of modern poetry. 1 unit.

434. **Major Movements in Modern British Fiction.** A study of important movements, figures, works, and ideas which shaped the criticism and practice of modern fiction. 1 unit.

437. **Studies in American Literature: 1600 to 1800.** Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor. Davidson.

438. **Studies in American Literature After 1800.** A course which investigates literary movements, major writers, and intellectual and cultural ideas in American literature from 1800 to the present. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: Survey course in American literature or consent of instructor. Davidson.

441. **Studies in Literary Theory.** The analysis, in accordance with aesthetic principles, of major documents in the history of poetics in order to formulate the central problems of literary theory and to examine proposed solutions to them. 1 unit.

442. **Studies in Recent Literary Theory.** The analysis of representative critics and critical schools of the twentieth century; similarities and differences between them and older critics in the solutions proposed to the central problems of literary theory. 1 unit.

445. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship. Required of all candidates for the degree of Doctor of Philosophy in English. ¼ unit.

446. **Introduction to Advanced Graduate Study.** A consideration of the methods and objectives of literary criticism and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. ¼ unit.

447. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. Hook.

448. **Literary Analysis for Teachers of English.** An examination of the theoretical considerations underlying various approaches to teaching literature at the high

school and introductory college level. 1 unit. Prerequisite: Teaching experience at secondary or college levels.

450. **Problems in Bibliographical Method.** Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor.

457. **Problems in Medieval Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. 1 unit.

458. **Problems in Sixteenth-Century Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 411, 412, or equivalent; or consent of instructor.

461. **Problems in Spenser.** A study of special problems relating to the works of Edmund Spenser, his background in England and in Ireland, and the second half of the sixteenth century. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: English 326 or any course on the sixteenth century.

462. **Problems in Tudor Drama.** 1 unit. HOLADAY.

463. **Problems in Shakespeare.** 1 unit.

464. **Problems in Elizabethan Drama.** 1 unit.

466. **Problems in Seventeenth-Century Metaphysical Poetry and Prose.** Literary technique in relation to intellectual and religious problems in the poetry and prose of John Donne, his contemporaries and successors. 1 unit. Prerequisite: English 345 or 417, or consent of instructor.

467. **Problems in Milton and His Age.** 1 unit. Prerequisite: English 342 or 418 or consent of instructor. BARKER.

471. **Problems in Eighteenth-Century Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 421, 422, or equivalent; or consent of instructor.

476. **Problems in Romantic Literature.** A conference and research course concerning special problems, literary movements, and writers of the English Romantic period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 427 and 428, or consent of instructor. STILLINGER.

478. **Problems in Prose Fiction.** 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Second-year graduate standing. GETTMANN.

479. **Problems in Victorian Literature.** Prerequisite: English 431 or 432 or consent of instructor. 1 unit. SMALLEY.

480. **The English Novel in Transition, 1890-1914.** An examination of the works of principal Edwardian novelists, chiefly John Galsworthy, Arnold Bennett, and H. G. Wells, in terms of the transition of the English novel from Victorian to modern. 1 unit.

484. **Problems in Twentieth-Century English Literature.** A conference and research course devoted to selected writers and critical movements of the period. 1 unit. Prerequisite: English 433 or consent of instructor.

486. **Problems in American Criticism and American Culture.** Papers and discussions on literary critics and historians who have used literature as an index to the problems of American culture, 1900-1959. 1 unit. Prerequisite: English 376.

488. **Problems in American Literature and Cultural History.** 1 unit. This course may be repeated for a total of two units. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN.

491. **Research in Special Topics.** Research in selected topics by arrangement with the instructor. This course may be repeated for a total of two units. 1 unit.

497. **Independent Reading.** A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrently with a 300-level course. No student may offer more than a total of ½ unit of English 497. Prerequisite: Consent of instructor of requisite 300-level course. ¼ unit.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. Barker, Berry, Campbell, Davidson, Flanagan, Gettmann, Green, Holaday, Hook, Lynen, McBurney, Millet, Milligan, Scott, Shattuck, Smalley, Stillinger, Stillwell, Tyler, Wilson.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Historical Introduction to the English Language.** Relation of English to other languages; major phonological, morphological, syntactic, and lexical changes in English from the beginnings to the present. ¾ unit. Prerequisite: English 246.

310. **Literature for the High School.** An introduction to the guidance of high school readings in literature, including a survey of books of graduated difficulty through an individualized program of independent reading, an examination of reference tools and teaching materials in English, but with chief emphasis upon an intensive critical study of representative works. ¾ unit.

311. **Chaucer.** ¾ unit. Stillwell.

316. **American Drama from 1900 to 1960.** A survey of American dramatic literature of the twentieth century, including the reading of a large number of plays which illustrate the diversity and importance of modern American drama. Special attention is given to the work of Maxwell Anderson and Eugene O'Neill. ¾ unit. Flanagan.

325. **English Literature from 1500 to 1660.** Survey of English literature of the Renaissance, exclusive of Milton and the drama. ¾ unit. Milligan.

326. **Spenser and His Contemporaries.** A study of the principal preoccupations and forms of Elizabethan poetry, with special reference to Spenser. ¾ unit. Prerequisite: Six hours of English literature.

336. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. ¾ unit.

338. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. ¾ unit.

339. **Comedy.** The history and theory of comic drama. ¾ unit. Shattuck.

340. **Satire.** Comparative study of the chief nondramatic satires of Western civilization, from Roman times to the present. Particular emphasis is given to the bearing these works and traditions have on English satire. ¾ unit. Offered in 1968-1969 and in alternate years.

342. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. ¾ unit.

345. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughn, Crashaw), with special emphasis on the poetry of John Donne. ¾ unit. Milligan.

346. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. ¾ unit.

348. **Swift, Pope, and Fielding.** A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. Written reports and extensive readings. ¾ unit. Prerequisite: A course in English literature.

349. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan; the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. ¾ unit.

351. **The Mid-Victorian Novel.** Thackeray, Emily Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. ¾ unit. SCHNEIDER.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. ¾ unit. DAVIDSON.

354. **Studies in Middle Western Literature, II.** A survey of Middle Western literature from 1900 to the present, with special emphasis on the development of realism in poetry and fiction. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

359. **The Origin and Development of the Folk Tale.** A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various countries (India, Greece, Norway, Ireland, Germany, Japan, and Africa) are analyzed, and North American Negro and Indian tales are discussed within this larger frame of reference. The semester's work concludes with an examination of folk motifs in the work of such American writers as Hawthorne, Poe, Melville, Twain, Faulkner, and others. ¾ unit. FLANAGAN.

360. **The Popular Ballad and the Folk Song in the United States.** A study of the British and Scottish popular ballad—the Child ballad as it is familiarly known—as it developed in Great Britain and as it was transplanted to the United States, with special emphasis on the development of native American ballads and songs. ¾ unit. FLANGAN.

362. **The Art of the Lyric.** A study of lyric poetry as a genre. The examination of the nature of lyric convention and lyric originality through the reading of a body of related poems with special attention to the poetic manifestation of language and metaphor. ¾ unit.

370. **Theory and Practice of Written Composition.** History and theory of written composition; basic rhetorical principles; guidance and criticism of student writing. ¾ unit.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as Speech 371. ½ or 1 unit.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as Speech 372. ½ or 1 unit.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. ¾ unit.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. ¾ unit. Prerequisite: English 113 and 114 or English 255 and 256.

377. **Major American Poets.** A study of Poe, Whitman, Dickinson, Frost, Eliot, and Cummings with emphasis upon critical interpretation of their writings and the

kinds of literary form characteristic of them. ¾ unit. Prerequisite: A course in English or American literature. LYNEN.

378. **Modern American and British Fiction in Its European Background.** A study of the interrelationship between certain themes and techniques in the development of the contemporary American, British, and European novel (from Dostoevsky, Melville, and Conrad through Mauriac, Dos Passos, Kafka, Gide, Faulkner, and Sartre to the present day). ¾ unit. Prerequisite: Two college-level literature courses.

380. **Mark Twain and the Rise of Realism.** A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900, ¾ unit. Prerequisite: English 114 or 256, or consent of instructor. SCOTT.

381. **Themes and Movements in British Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. Prerequisite: Six hours of English or American literature.

382. **The Plays of Bernard Shaw.** ¾ unit. SHATTUCK.

384. **Comparative Studies in Twentieth-Century Poetry.** A study of contemporary poetry in English in its relationship to modern European verse. The poets studied may vary each time the course is offered. ¾ unit. Prerequisite: Three hours in either poetry or modern literature, or consent of instructor.

385. **Themes and Movements in American Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. ALTENBERND, HODGINS.

386. **Modern English Grammar and Usage.** Traditional and contemporary grammars; principles of usage. ¾ unit.

387. **The Structure of English.** Same as Linguistics 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit.

Rhetoric and Composition

COURSES FOR GRADUATES

400. **Verbal Communication in English as a Second Language for Graduate Foreign Students, I.** A language laboratory course concentrating on the typical writing problems that a graduate or research student encounters in an American university. No graduate credit. Prerequisite: Rhetoric 111 or consent of instructor.

401. **Verbal Communication in English as a Second Language for Graduate Foreign Students, II.** A language laboratory course dealing with individual, immediate, and specialized speaking and writing problems, with particular attention to orienting the graduate student to the techniques of the American university in thesis and other specialized writings and in the oral presentation of such material. No graduate credit. Prerequisite: Rhetoric 400 or consent of instructor.

419. **Contrastive Linguistics.** Same as Linguistics 419. A critical survey of contemporary linguistic models with special reference to their relevance in preparing contrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-western languages at different linguistic levels. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

330. **The Writing of Poetry.** The practice of the writing of poerty, aided by intensive study of examples. ¾ unit. Prerequisite: Six hours of English or American literature, or consent of instructor.

388. **Linguistics in Language Learning, I.** Same as Linguistics 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language or equivalent; consent of instructor.

389. **Linguistics in Language Learning, II.** Same as Linguistics 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguisticis, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Rhetoric 388.

ENTOMOLOGY

See descriptions and course listings under Life Sciences, page 238.

EXTENSION EDUCATION

This program leads to the professional degree of Master of Extension Education and is open to persons holding a bachelor's degree in agriculture, home economics, or a closely related area. Admission to the program requires a grade-point average of at least 3.5 for the last sixty semester hours of undergraduate work.

Candidates are required to complete a minimum of eight units, and nine units are required if a thesis is not submitted. Three of these units must be in 400-level courses with one unit in the major field. A major (four units) may be taken in agriculture, home economics, or the social sciences. Students majoring in agriculture or home economics select four additional units from the social sciences; those majoring in the social sciences select four additional units from agriculture or home economics. All courses selected must be approved by the student's adviser. If a thesis is not submitted, the ninth unit may be selected in any area approved by the adviser. Students majoring in home economics must take work in three of the four major divisions of the department, unless proficiency in one or more of the areas is demonstrated by examination. At least four units must be earned in residence on the Urbana campus. Total extramural credit can not exceed three units.

Inquiries concerning the Master of Extension Education should be directed to Professor Ernest W. Anderson, 116 Mumford Hall.

FINANCE

The Department of Finance offers graduate work leading to the Master of Science and Doctor of Philosophy in Finance. The following fields are available for specialization within the department: money, credit, and banking; corporation finance; corporation history; investment; insurance; urban land utilization.

The grade-point average required for admission to graduate study in the department is 3.75, although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis. A candidate for a degree in finance must also meet the general admission requirements of the Graduate College. He must also

have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

A candidate for the Doctor of Philosophy must pass a preliminary examination. Graduate study in accountancy or statistics, or both, is advised strongly for doctoral candidates majoring in finance.

The Doctor of Philosophy program for the first year must include (1) two units of economic theory, (2) four units of finance, and (3) two additional units in finance or related fields. Two of the finance units should be in thesis research. The second year of study includes eight units which provide (1) a concentration in finance, (2) understanding of one or more fields in economics in addition to economic theory, and (3) proficiency in any other related minor field offered.

GRADUATE FACULTY

Professors: P. M. Van Arsdell (Head of Department), C. T. Arlt, R. A. Hedges, R. W. Mayer, R. I. Mehr, R. C. Osborn.

Associate Professors: T. E. Cammack, J. W. Leonard.

Assistant Professor: J. R. Pike.

COURSES FOR GRADUATES

420. **Central Banking Policy.** An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. 1 unit. Arlt.

425. **The Money Market and Financial Stabilization.** A study of interest rate determination; the structure and operations of the money and capital markets; the objectives and implementation of monetary, fiscal, and debt management policies. 1 unit. Prerequisite: Finance 150. Arlt.

427. **Commercial Bank Management.** A study of the principal policies and problems which confront top management. Major emphasis is given to liquidity, loans, investments, deposits, and captial funds, but consideration is also given to bank statements, organization structure, operations, personnel, cost analysis, and public relations. Instructional methods utilize readings, cases, and research projects. 1 unit. Prerequisite: Finance 150.

454. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. 1 unit. Prerequisite: Finance 254. Van Arsdell.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investments, on a critique of investment policy, and on the valuation of investment media. 1 unit. MAYER.

460. **Theory of Insurance.** A study of the nature and cost of risk in our economic society and of the methods of handling it. 1 unit. MEHR.

490. **Individual Study and Research.** Directed reading and research. ½ to 1 unit. STAFF.

499. **Thesis Research.** Required for those writing master's and doctor's theses in finance. 0 to 4 units. MAYER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **Consumer Finance.** Nature and importance of consumer finance; trends in consumer credit; instruments and institutions of consumer credit; economic effects of consumer finance; consumer credit and public policy. ½ to 1 unit. Extra work is required of graduate students who register for 1 unit. Prerequisite: Finance 150 and 254, or consent of instructor.

357. **Financing Small Business.** Size and nature of small business; significance and limitations of small business; financial structure and problems; financial assistance to small business; future prospects of small business. ½ to 1 unit. Prerequisite: Finance 254 or 257. OSBORN.

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities, of senior securities with speculative features, of common stocks, of government and municipal securities, and of investment company securities. ½ to 1 unit. Prerequisite: Accountancy 108; Finance 254. MAYER, PIKE.

360. **Employee Benefit Plans.** Same as Labor and Industrial Relations 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans and to "qualified" pensions and profit-sharing plans for regular employees; some attention is given to special, supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 351; or consent of instructor.

363. **Estate Planning.** A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. ½ to 1 unit. Prerequisite: Finance 262. MEHR.

368. **Survey of Urban Real Estate.** A broad survey of the field of real estate and urban land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor.

369. **Urban Land Problems.** A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for individual study. Whenever possible the problems are selected and developed jointly with the departments of Urban Planning, Landscape Architecture, Architecture, and others. ½ to 1 unit. Prerequisite: Finance 368 or consent of instructor.

370. **Risks and Risk Management.** Analysis of the financial problems in the risks of property damage or bodily injury in business situations and evaluation of the

alternative methods for dealing with such problems. ½ to 1 unit. Prerequisite: One of the following: Accountancy 105 or 201; Economics 103 or 108; Finance 254 or 257. HEDGES

FOOD SCIENCE

(Including Dairy Technology)

The Department of Food Science offers graduate work leading to the Master of Science and Doctor of Philosophy in either Food Science or Dairy Technology. The grade-point average required for admission to graduate study is 3.75, although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis.

To obtain a graduate degree in food science, a student must have credit (graduate or undergraduate) in Chemistry 350 and 355, Microbiology 311 and 312, Food Science 301, 302, 421 (M.S., one-fourth unit; Ph.D., one-half unit), and 499 (M.S., two units; Ph.D., eight units).

Doctor of Philosophy. Candidates for the Doctor of Philosophy should complete formal course work and satisfy the language requirements (German, and French or Spanish) by the end of the second year of residence so that a minimum of one year may be spent in research. Each candidate must take a comprehensive written examination before the oral preliminary examination for the doctorate.

Graduate credit courses offered outside the Department of Food Science may be applied in partial satisfaction of the major unit requirements. These may be selected from closely related fields of study, such as microbiology, chemistry, physics, engineering, and applied biological sciences, and are subject to the approval of the major department. Minors may be selected from these same fields as well as from economics and management.

Second-year and third-year graduate students are expected to attend all seminars in dairy technology (Dairy Technology 404), but they can register for a maximum of only one-half unit of credit. Dairy Technology 403, Agronomy 440, and Dairy Technology 499 (eight units) are also required for the Doctor of Philosophy.

A student planning to take a major or minor in food science should have a Bachelor of Science in a recognized field of biological, physical, agricultural, or engineering science in which a minimum of the undergraduate credits are as follows: biology, six hours; physics, eight hours; calculus, five hours; microbiology, five hours; analytical chemistry, five hours; organic chemistry, five hours; physical chemistry, four hours; and food science or equivalent, twenty hours.

Master of Science. To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350 and 355, Dairy Technology 401 (one unit), 404 (one unit), and 499 (two units). A course in statistics is also necessary unless such a course was taken by the student when an undergraduate. The remainder of the eight units required for the Master of Science can be taken in the major and minor fields.

Research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing.

Candidates for the master's degree must complete one language requirement (German, French, or Spanish) and one minor and are required to take an examination covering the field of general food science and of their specialization. The candidate must present a thesis unless this requirement is waived by petition to the department.

GRADUATE FACULTY

Professors: R. T. MILNER (Head of Department), E. O. HERREID, L. B. HOWARD, F. A. KUMMEROW, A. I. NELSON, Z. J. ORDAL, D. SGOUTAS, M. P. STEINBERG, J. TOBIAS, S. L. TUCKEY, R. M. WHITNEY.

Associate Professors: T. Nishida, H. K. Wilson, L. D. Witter.
Assistant Professors: C. Argoudelis, K. A. Narayan, E. G. Perkins, L. Wei.

Food Science

COURSES FOR GRADUATES

404. **Special Topics in Food Science, III: Technology of Fats and Oils.** A study of the commercial technology of fats and oils, including soaps and protective coating. Offered in 1968-1969 and in alternate years. ½ unit. Prerequisite: Food Science 391 or consent of instructor. Narayan.

406. **Special Topics in Food Science, IV: State and Metabolism of Lipids.** An advanced study of the state of lipids in animal tissues and in biological fluids, and of the metabolism of lipids in relation to dietary fats and other food constituents. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Chemistry 350 or consent of instructor. Nishida.

421. **Seminar.** Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food science. ¼ unit. Staff.

430. **Carbohydrates in Foods.** Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 355, 354, or 350, or consent of instructor.

481. **Advanced Studies in Food Science.** Library or laboratory assignments on specific problems of limited scope involving individual commodities or processes. ½ to 2 units. Staff.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, dehydrating, and fermenting methods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 201. Nelson, Wei.

302. **Food Processing.** Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables; and cereals; preservation of meats and poultry products; vacuum and freeze drying of foods; evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 202 and 301. Nelson, Wei.

332. **Principles of Sanitation in the Processing and Handling of Foods.** A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and micro-organisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulation. Local field trips to food processing plants. ½ unit. Prerequisite: Microbiology 100 and 101; Chemistry 102. Ordal, Witter.

363. **Introduction to Process Engineering.** Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems.

¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Chemistry 340 or 342; one year of calculus; or consent of instructor.

373. **Advanced Food Microbiology.** A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. 1¼ units. Offered in 1967-1968 and in alternate years. Prerequisite: Chemistry 133; Microbiology 311 and 312. Ordal, Witter.

391. **Special Topics in Food Science, I: Chemistry of Lipids in Foods.** A detailed survey of the chemical and physical properties of lipids. Offered in 1968-1969 and in alternate years. ½ unit. Prerequisite: Credit or registration in Chemistry 350, or consent of instructor. Perkins.

393. **Special Topics in Food Science, II: Experiments in Lipid Chemistry.** Laboratory exercises, demonstrations, and assigned readings. Offered in 1968-1969 and in alternate years. ½ unit. Prerequisite: Registration in Food Science 391 or consent of instructor. Argoudelis.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy Technology.** Study of fundamentals and fundamental problems involved in the processing of milk and milk products. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Chemistry 350. Herreid.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. Whitney.

404. **Seminar.** Review of current literature in dairy technology. Students may register for credit only twice for a maximum of one-half unit. ¼ unit. Staff.

491. **Assigned Problems in Dairy Technology.** Research on special problems for graduate students with a major interest in dairy technology. ½ to 2 units. Staff.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Dairy Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. ½ unit. Prerequisite: Consent of instructor. Wilson.

310. **Dairy Product Processing.** Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, dried milk, and ice cream. 1 unit. Prerequisite: Food Science 201; Dairy Technology 211; credit or registration in Dairy Technology 213. Herreid.

311. **Dairy Product Processing.** Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, casein, lactic acid, lactose, and fermentation products of whey. 1 unit. Prerequisite: Dairy Technology 211 and 213. Tuckey.

312. **The Chemistry of Milk and Milk Products.** Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. Offered in 1968-1969 and in alternate years. ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 213 or Chemistry 122. Whitney.

FORESTRY

The Department of Forestry offers graduate work leading to the degree of Master of Science in Forestry to graduates of forestry curricula substantially equivalent, in scope and standards, to those of the University of Illinois. The minimum grade-point average for admission to graduate study is 3.75. The program is intended for the forestry graduate who desires to deepen his understanding of the scientific principles which underlie some particular phase of forestry, such as forest ecology, economics, genetics, management, mensuration, protection, soils, aerial photo interpretation, or wood technology.

In consultation with his adviser, a student plans a program which meets the general requirements of the Graduate College and serves his particular needs and interests. Such a program must include a seminar in forestry and, in most instances, original research and the presentation of a thesis on an appropriate problem. The thesis requirement may be waived only if, in the judgment of the departmental graduate committee, such waiver will result in a better program in a specific case. Advanced courses related to the student's special interest are found in such areas as biometrics, botany, climatology, economics, entomology, genetics, mathematics, photogrammetry, plant pathology, and soil science (see under departmental listings).

A candidate must earn eight units of graduate credit, with at least three units in courses at the 400 level. He must also pass an oral examination covering the general field of forestry and the area of his specialization.

GRADUATE FACULTY

Professors: T. E. Avery (Head of Department), W. R. Boggess, I. I. Holland, C. S. Walters.

Associate Professor: R. G. Rennels.

Assistant Professor: J. J. Jokela.

COURSES FOR GRADUATES

400. Seminar. Discussions on specialized topics and current literature in forestry. Required of all graduate students in forestry. ¼ unit. May be taken twice for a total credit of one-half unit. Staff.

401. Special Problems. Individual studies or investigations in selected branches of forestry. ½ to 1 unit. Not more than one unit may be offered for an M.S. degree. Staff.

440. Design and Analysis of Biological Experiments, I. Same as Agronomy, Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. Carmer.

441. Design and Analysis of Biological Experiments, II. Same as Agronomy, Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Forestry 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Forestry 440 or equivalent. Carmer.

499. Thesis Research. Research may be conducted in various phases of forestry. Subject must be approved by departmental committee. 1 to 3 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. Forest Soils. Soil factors related to forest hydrology and tree growth. Graduate students are required to attend a special seminar. ½ unit. Prerequisite: Agronomy

101 and Forestry 212; or graduate standing in botany with Botany 381 or equivalent. Boggess.

362. **Forest Entomology.** A study of the characteristics, life histories, and forest relationships and controls of the economically important forest insects of the United States. ½ unit. Prerequisite: One year of biological science; one year of chemistry. Rennels.

FRENCH

The Department of French offers graduate work leading to the Master of Arts, Master of Arts in the Teaching of French, and Doctor of Philosophy.

Students are admitted with a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Students electing French as a major subject should have had a college major in French, including practical work in the use of the language and advanced work in literature. Some knowledge of other Romance languages and literatures is desirable. A reading knowledge of Latin based on three years of high school Latin or three semesters of college Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates must pass an examination based on a general reading list. Candidates preparing to teach French must take French 311, 313, and 314 unless they can demonstrate proficiency.

Doctor of Philosophy in French. Candidates are expected to take at least two units in seminar courses. Candidates also are required to include French 475 and 476, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject. French 406 also is required.

Master of Arts in the Teaching of French. Candidates for the Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 311, 313, 314, two units; two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. See pages 41 and 42.

GRADUATE FACULTY

Professors: B. H. Mainous (Head of Department), F. Jost, C. A. Knudson, P. Kolb, C. P. Viens.

Associate Professors: P. E. Barrette, F. Bassan, V. E. Bowen, H. C. De Ley, S. E. Gray, E. Jahiel, F. W. Nachtmann, J. K. Simon.

Assistant Professors: Barbara C. Bowen, F. M. Jenkins, M. K. Myers.

COURSES FOR GRADUATES

400. **Beginning French for Graduate Students.** Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit.

401. **Reading French for Graduate Students.** Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the

French reading requirements for the Ph.D. No graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

405. **Teaching College French.** A study of the problems of teaching French at the college level, including classroom procedures and language laboratory techniques. No credit.

406. **Research Methods.** Orientation in graduate research, introduction to bibliographical problems, and survey of methodology for papers and dissertations. ¼ or ½ unit. V. E. Bowen.

Note: In any given year a selection from the following courses is offered. For current information, consult the department office or the current semester Time Table.

407. **French Literary Criticism, I: History of French Literary Criticism from the Sixteenth to the Twentieth Centuries.** Literary theory and practice of criticism as developed in France from the sixteenth to the twentieth centuries. Analysis and discussion of preoccupations, critical methods, and approaches to literature of representative critics, with emphasis upon emergence of philosophies of criticism. 1 unit.

408. **French Literary Criticism, II: Studies in Recent French Criticism.** Study of important trends in French literary criticism of the mid-twentieth century, relating these trends to critical problems and theories of literature of the late nineteenth century and the earlier part of the twentieth. 1 unit.

421. **Literature of the French Renaissance.** Discussion and analysis of some of the more important intellectual and religious preoccupations of the sixteenth century, as reflected in representative texts by important writers of the period. 1 unit.

424. **Studies in French Poetry.** Versification, poetic structure, problems of imagery and meaning, and practical work in the interpretation of individual poems. 1 unit. Gray.

425. **Explication de textes, I.** Exercises according to the method of *explication de textes*, applied to texts selected principally from the period 1944-1958. 1 unit.

426. **Explication de textes, II.** The French method of *explication de textes* applied to selected texts of the principal French writers, in particular the *penseurs et essayistes*. 1 unit.

431. **History of Old French Literature, I.** Lectures on the history of French literature from the eleventh through the fifteenth century, with illustrative reading in translation. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Graduate standing in French or related department. Knudson.

432. **History of Old French Literature, II.** 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Graduate standing in French or related department. Knudson.

433. **Villon, Rabelais.** 1 unit. Offered in 1967-1968 and in alternate years. B. Bowen.

434. **Studies in Montaigne.** A discussion of the most important aspects of Montaigne as a writer, and of his place in French literature. 1 unit.

435. **Seventeenth-Century Literature, I.** 1 unit. Offered in 1967-1968 and in alternate years.

436. **Seventeenth-Century Literature, II.** 1 unit. Offered in 1967-1968 and in alternate years.

437. **Eighteenth-Century Literature, I.** 1 unit. Offered in 1968-1969 and in alternate years. V. Bowen, Jost.

438. **Eighteenth-Century Literature, II.** 1 unit. Offered in 1968-1969 and in alternate years. V. Bowen, Jost.

447. **Nineteenth-Century Literature to 1850, I.** 1 unit. Offered in 1968-1969 and in alternate years. Bassan.

448. **Nineteenth-Century Literature to 1850, II.** 1 unit. Offered in 1968-1969 and in alternate years. Bassan.

453. **French Realism and Naturalism, I.** 1 unit. Offered in 1967-1968 and in alternate years.

454. **French Realism and Naturalism, II.** 1 unit. Offered in 1967-1968 and in alternate years.

457. **Seminar in Proust, I.** ½ unit. Offered in 1968-1969 and in alternate years. Kolb.

458. **Seminar in Proust, II.** ½ unit. Offered in 1968-1969 and in alternate years. Kolb.

459. **Seminar in Modern French Literature, 1870 to 1935.** An intensive study of one or two authors of the late nineteenth and early twentieth centuries. Authors who may be studied include the Parnassian or Symbolist poets and the following novelists: Barrés, Bourget, Anatole France, Loti, Gide, Martin du Gard, Duhamel, Mauriac, Giraudoux. 1 unit. Students may receive credit more than once.

460. **Seminar in French Literature.** Discussion and research on some specialized area in French literature. Topic will be announced in advance. Course may be repeated for credit. 1 unit.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

463. **La Poésie Symboliste.** An intensive study of two of the following major poets: Nerval, Baudelaire, Rimbaud, Mallarmé. 1 unit.

464. **Du Cubisme au Surréalisme.** A study of the poetic and theoretical writings of Apollinaire, Reverdy, Jacob, Breton, and Eluard. 1 unit.

465. **La Littérature Contemporaine, I.** In French. Twentieth-century poets and novelists. 1 unit. Offered in 1968-1969 and in alternate years. Gray, Simon.

466. **La Littérature Contemporaine, II.** 1 unit. Offered in 1968-1969 and in alternate years. Gray, Simon.

475. **Old French Philology, I.** Reading of characteristic masterpieces of medieval French literature and study of the development of the Old French language from Latin. 1 or 1¼ units. Offered in 1968-1969 and in alternate years. Prerequisite: Consent of instructor; elementary knowledge of Latin; reading knowledge of German. Knudson.

476. **Old French Philology, II.** 1 or 1¼ units. Offered in 1968-1969 and in alternate years. Prerequisite: French 475. Knudson.

491. **Individual Topics.** ¼ to 1 unit. Staff.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The prerequisite for all courses in this group is French 201 and 202, or equivalent.

311. **French Diction.** Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course and French 313 be taken concurrently. ½ unit. Prerequisite: Consent of instructor. Viens.

313. **French Phonetics.** A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 311 be taken simultaneously. ¾ unit. Prerequisite: Consent of instructor. Jenkins, Myers.

314. **French Syntax.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. ¾ unit. Prerequisite: French 213 and 214, or equivalent.

316. **Structure of the French Language.** A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313 or equivalent training in phonetics. JENKINS.

335. **French Civilization, I.** In French. A survey of French life and French institutions, intended as a background for literary studies and as a preparation for the teaching of French. ¾ unit.

336. **French Civilization, II.** ¾ unit.

382. **Language Laboratory Techniques.** Same as German, Slavic, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS.

GENERAL ENGINEERING

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE FACULTY

Professors: J. S. DOBROVOLNY (Head of Department), B. O. LARSON, E. C. MCCLINTOCK, J. E. PEARSON.

Associate Professor: F. L. SPALDING.

Assistant Professor: R. J. PLACEK.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Professional Expression.** Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. MCCLINTOCK.

313. **Advanced Methods in Engineering Graphical Computations.** Application of determinants in the theory and construction of engineering nomograms; curve fitting and formulation of empirical formulae; methods and application of graphical calculus. ½ to 1 unit. Prerequisite: Mathematics 142 or equivalent. PLACEK.

330. **Industrial Standardization.** Evolution and history of standardization; local, national, and international standardization; governmental standardization. Special emphasis is placed on standardization procedures for individual industrial establishments. ½ unit. Prerequisite: Consent of instructor. SPALDING.

334. **Introduction to Reliability Engineering.** Same as Industrial Engineering 334. An introduction to concepts in engineering design, testing, and management for highly reliable components and systems. ¾ or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor.

360. **Engineering Applications of Meteorological Fundamentals.** The application of the fundamentals of meteorology to engineering problems including the trans-

port and diffusion of particulate matter, aerosols, and gases; precipitation processes and rainout; behavior of stack effluents, explosion debris, and radioactive materials in the atmosphere. Applications to operation scheduling and to site selection. 1 unit. Prerequisite: Mathematics 142 or 143; Physics 106, 107, and 108; Mechanical Engineering 205 and 206, or 209, or Chemistry 342 and 344, or Physics 360. PEARSON.

393. **Special Problems.** Study of advanced problems related to general engineering and graphics. ½ to 1 unit. Prerequisite: Consent of instructor. LARSON, STAFF.

GENETICS

A Doctor of Philosophy program in genetics is provided through the cooperative efforts of eight different departments of biology and is administered by the University Committee on Genetics. Training in biochemical genetics, cytogenetics, and population genetics of a variety of organisms is provided. Students seeking master's degrees are directed to the various departmental programs, or to the master's program in biology offered by the School of Life Sciences.

Applicants for admission should have at least a 4.0 grade-point average for the last sixty hours, but may be considered for admission with a 3.75 average. They should also have completed one year of college physics, quantitative and organic chemistry, trigonometry, and analytic geometry. Calculus is strongly recommended. During the first calendar year of graduate study, students are required to take an advisory examination in the major genetic areas.

During the first two years, candidates should complete courses or demonstrate proficiency in biological chemistry (Chemistry 350, 355), calculus (Mathematics 132, 142, or 133, 143), statistics (Mathematics 363 or Agronomy 440), cytology (Botany 420), cytogenetics (Botany 421), population genetics (Animal Science or Dairy Science 411, or Zoology 407), and microbial genetics (Microbiology 330). All programs of study must be approved by the Genetics Committee. Students wishing a sole minor in genetics are required to complete four units of work in areas approved by the Committee and including at least three-fourths unit in a 400-level course outside the major area.

Students majoring in genetics ordinarily elect minors in one of the biology departments and in either chemistry or mathematics. Students in the genetics program are eligible for fellowships and assistantships in the participating departments and should indicate their departmental preference (Agronomy, Animal Science, Botany, Dairy Science, Horticulture, Microbiology, Psychology, or Zoology) when applying for admission.

Thesis research may be carried out under the direction of appropriate staff members in the participating departments under departmental course listings. Inquiries concerning the program should be directed to the Chairman of the Genetics Committee, Professor Denton E. Alexander, S-110 Turner Hall.

GEOGRAPHY

The Department of Geography offers work leading to the Master of Arts, Master of Science, and Doctor of Philosophy. The systematic specializations of the department are: theoretical and applied area development, regional geography, and physical-ecological geography.

Students applying for admission must have a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All candidates for advanced degrees in geography must have an average of at least 4.25 in previous work in geography.

Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose backgrounds are largely in physical geography are recommended for the Master of Science; others receive the Master of Arts.

At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the departmental graduate committee. Students must have had, either as undergraduates or as graduates, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of a University of Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political science, sociology, or anthropology are recommended in the social sciences.

Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are geography electives, two units in education, and two units in electives. The grade-point average required for admission is 3.5. See pages 41 and 42. The adviser for candidates for this degree is Professor J. H. Garland, 224 Davenport Hall.

Doctor of Philosophy. The doctoral student is expected to penetrate deeply into specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for this degree must have taken, either as undergraduates or as graduates, all work required in the undergraduate major and the master's and doctor's programs of the department or the equivalent.

Admission to candidacy for the Doctor of Philosophy in geography is recommended after the successful completion of:

(1) At least sixteen units of graduate credit, or equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography. The department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology; the other in anthropology, economics, history, political science, sociology, Latin-American studies, or Russian studies. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination.

After being admitted to candidacy for the Doctor of Philosophy, the student must complete a research thesis, eight units of Geography 499, which normally requires field investigation.

GRADUATE FACULTY

Professors: A. W. Booth, J. D. Fellmann, F. W. Foster, J. H. Garland, H. G. Roepke, J. A. Russell, D. B. Shimkin.

Associate Professors: J. Thompson (Head of Department), C. S. Alexander.

Assistant Professor: R. W. Armstrong.

COURSES FOR GRADUATES

412. **Analytical Climatology.** A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Armstrong.

421. **Regional Concepts in Geography.** Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philos-

ophy; regionalism in applied geography. ½ unit. Prerequisite: Nine hours of regional geography. GARLAND.

429. **The Evolution of Agricultural Economies.** Same as Agronomy and Anthropology 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. ALEXANDER, STAFF.

461. **Fundamentals of Bioclimatology.** Same as Physiology 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor. ARMSTRONG, SARGENT.

462. **Experimental Bioclimatology.** Same as Physiology 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Geography 461. ARMSTRONG, SARGENT.

463. **Historical Geography.** Objectives and methods of historical geography. 1 unit. RUSSELL.

464. **Advanced Human Bioclimatology.** Same as Physiology 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Geography 461. ARMSTRONG, SARGENT.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. 1 unit. Prerequisite: Geography 373 or consent of instructor. FOSTER.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. 1 unit. FOSTER.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. ½ to 2 units. Work may be taken in the following fields:
   (a) **Physical Geography, Africa, Agricultural Origins.** ALEXANDER.
   (b) **Medical Geography, Australia and New Zealand, Quantitative Geography.** ARMSTRONG.
   (c) **Asia, Resource Management, Transportation.** BOOTH.
   (d) **Urban Geography, U.S.S.R.** FELLMANN.
   (e) **Middle East, Advanced Cartography.** FOSTER.
   (f) **Anglo America, Political Geography, Regionalism.** GARLAND.
   (g) **Economic Geography, Industrial Location, Europe.** ROEPKE.
   (h) **Europe, Marketing Geography.** RUSSELL.
   (i) **Human Ecology, U.S.S.R.** SHIMKIN.
   (j) **Latin America.** THOMPSON.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. ½ unit. FELLMANN.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the acquisitions, care, and library use of maps. Classes become familiar with the major cartobibliographical and related aids. ½ unit. Prerequisite: Consent of instructor. WHITE.

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. ¾ unit. Prerequisite: Geography 101 and 111. ARMSTRONG.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. ¾ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

323. **Geography of the North American Midwest.** The core of the North American continent; detailed analysis of the functions and patterns of the Midlands and their external relations. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. GARLAND.

332. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. ¾ unit. Prerequisite: Eight hours of geography or enrollment in Latin-American studies program, or consent of instructor. THOMPSON.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. RUSSELL.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. ¾ unit. Prerequisite: Eight hours of geography, consent of instructor, or enrollment as a major or minor in Russian language and area studies. FELLMANN.

355. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

357. **Geography of the Middle East and North Africa.** A regional geography of an area with limits largely defined in terms of Arab and Moslem influences or closely related cultural and historical circumstances. The course is oriented around the strategic centrality of the core of the territory as the crossroads of Europe, Asia, and Africa. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. FOSTER.

361. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. ¾ unit. FOSTER.

362. **Geography of Manufacturing.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. ¾ unit. Offered in 1968-1969 and in alternate years. ROEPKE.

363. **Geography of Minerals.** Geographic aspects of the mineral industries. ¾ unit. Offered in 1967-1968 and in alternate years. Roepke.

365. **Geography of Transportation.** A consideration of the agents of transportation (land, water, air), the routes of transportation, transportation terminal complexes, and the basic commodity exchange services of transportation within the framework of their regional interregional relationships. ¾ unit. Booth.

366. **Location of Industry and Other Economic Activities: Theory and Practice.** Locational theory applied to the relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites; study of factors affecting location of stores and other commercial activities. ¾ unit. Fellmann, Roepke.

369. **Introduction to Human Ecology.** Same as Anthropology, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. Shimkin, Staff.

370. **Quantitative Methods in Geography.** Geographical applications of statistical and mathematical research techniques. ¾ unit. Prerequisite: Geography 185, or one year of college mathematics, or one course in statistics, or the equivalent. Armstrong.

371. **Introduction to Research.** Introductory training in bibliographical and cartographic techniques as source materials of geographic research. Limited to students whose major is geography and to seniors whose major is in other departments but who have twelve hours of geography. ¾ unit. Fellmann, Staff.

372. **Introduction to Research.** Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. ½ unit. Staff.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. 1 unit. Prerequisite: Consent of instructor. Foster.

374. **Problems in Human Ecology.** Same as Anthropology, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Geography, Anthropology, Health Education, Physiology, Sociology, or Zoology 369. Shimkin, Staff.

378. **Descriptive Interpretation of Remote Sensors.** Descriptive interpretation of remote-sensing images with emphasis on interpretation of aerial photography; applications of aerial photography and photographic interpretation to the solution of problems in the major field of the individual student. Two half-day field trips on Saturdays are required. 1 unit. Prerequisite: Consent of instructor. Booth.

381. **Russian Culture History and Ethnology.** Same as Anthropology 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions from Danubian to contemporary times. ½ or 1 unit. Shimkin.

382. **Siberian Culture History and Ethnology.** Same as Anthropology 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. ¾ unit. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; Western Hemisphere nations. ¾ unit. GARLAND.

GEOLOGY

Graduate students may take work in the Department of Geology leading to the Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, mathematics, and in chemistry, physics, or biology rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, geochemistry, geomorphology and glacial geology, mineral deposits, mineralogy and petrology, oceanography, paleontology and stratigraphy, ground-water geology, sedimentation, sedimentary petrography, structural geology, and submarine geology.

Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, geomorphology, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and mathematics. He may substitute advanced courses in mathematics, chemistry, physics, or the biological sciences for certain geology courses with departmental approval.

A candidate for the doctor's degree may select a minor in chemistry, physics, mathematics, mining or civil engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

Master of Science in the Teaching of Earth Science. Candidates for the Master of Science in the Teaching of Earth Science must earn four units in geology; two units in other earth science areas; and two units in education including History and Philosophy of Education 303 and 304 and Educational Psychology 311 and 312.

GRADUATE FACULTY

Professors: F. A. DONATH (Head of Department), A. CAROZZI, C. A. CHAPMAN, D. U. DEERE, J. C. FRYE, A. F. HAGNER, P. R. SHAFFER, G. W. WHITE.

Associate Professors: R. N. FARVOLDEN, W. W. HAY, D. M. HENDERSON, R. LANGENHEIM, A. F. RICHARDS, F. M. WAHL.

Assistant Professors: C. J. MANN, P. A. SANDBERG.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. 1 unit. Offered in 1968-1969 and in alternate years.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. 1 unit. Offered in 1967-1968 and in alternate years.

403. **History of Geology.** 1 unit. WHITE.

409. **Sedimentation.** 1 unit.

415. **Geology of the Upper Mississippi Valley.** Field study of the geology of Illinois and adjacent states by means of five or six two-day field trips and the preparation of reports; estimated travel expense, $60.00. 1 unit. LANGENHEIM.

420. **Paleoecology.** Interpretation of life habit of fossil organisms from skeletal morphology and associated depositional features; reconstruction of marine ecosystem relations from the study of assemblages of fossils. 1 unit. Prerequisite: Geology 320 or equivalent. HAY.

422. **Stratigraphic Geology: Paleozoic.** 1 unit. Prerequisite: Geology 321.

423. **Stratigraphic Geology: Mesozoic and Cenozoic.** 1 unit. Prerequisite: Geology 321. LANGENHEIM.

425. **Micropaleontology: Foraminifera.** Classification of microfossils, foraminifera; stratigraphic correlation. 1 unit. Prerequisite: Geology or Zoology 320. SANDBERG.

426. **Micropaleontology: Ostracoda.** Classification of microfossils, ostracods, conodonts, scolecodonts, and other major groups, stratigraphic correlations. 1 unit. Prerequisite: Geology or Zoology 320. SANDBERG.

430. **Crystallography.** A consideration of the approaches and techniques required for an understanding of the structures and properties of crystals, especially those of minerals; emphasis is given to the development of pattern theory, space groups, and their applications. 1 unit. Prerequisite: Geology 335 or equivalent; consent of instructor. HENDERSON.

431. **Structural Mineralogy.** Principles of the crystal chemistry and structural classification of minerals, and survey of the current knowledge about the structures and structurally dependent properties and behavior of representative minerals and mineral groups. 1 unit. Prerequisite: Geology 430; consent of instructor. HENDERSON.

432. **Geochemistry.** A chemical approach to the interpretation of geological processes with emphasis on principles which control the distribution and migration of elements in geological environments. 1 unit. Prerequisite: Geology 336 or Chemistry 321, or equivalent; consent of instructor. WAHL.

435. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. 1 unit. CHAPMAN.

436. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied, and special methods of investigation are covered. 1 unit. CHAPMAN.

437. **Sedimentary Petrology.** A study of sedimentary petrogenesis, including erosion, transportation, deposition, consolidation, diagenesis, and lithification. 1 unit. Prerequisite: Geology 335. RICHARDS.

438. **Sedimentary Petrography.** Microscopic study of sedimentary rocks in thin section with emphasis on textures and structures, as a basis for their detailed classification and genetic interpretation. 1 unit. Prerequisite: Geology 335 and 437. CAROZZI.

440. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. 1 unit. HAGNER.

443. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. 1 unit. Prerequisite: Geology 311. HAGNER.

444. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. 1 unit. Prerequisite: Geology 443. HAGNER.

450. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

455. **Hydrogeology.** The geology of the occurrence, storage, movement, and quality of water in the rocks of the Earth's crust. 1 unit. Prerequisite: Consent of instructor. FARVOLDEN.

461. **Mineralogy of Clays.** Same as Ceramic Engineering 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. **Mineralogy of Clays.** Same as Ceramic Engineering 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461.

471. **Submarine Geology.** General geology of the ocean basins and continental margins, with emphasis on the geological interpretation of marine geophysical investigations. 1 unit. Prerequisite: One year of physics or consent of instructor. RICHARDS.

493. **Advanced Studies in Geology.** ½ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** WAHL.
(b) **Engineering Geology.** DEERE, RICHARDS.
(c) **Geomorphology and Glacial Geology.** SHAFFER, WHITE.
(d) **Geotectonics.** CAROZZI.
(e) **Ground-Water Geology.** FARVOLDEN.
(f) **Micropaleontology.**
(g) **Mineral Deposits.** HAGNER.
(h) **Mineralogy and Crystallography.** HENDERSON.
(i) **Paleobotany.** (See Botany 493j.) PHILLIPS.
(j) **Paleontology.** HAY.
(k) **Pennsylvanian Stratigraphy.**
(l) **Petrography and Petrology.** CHAPMAN.
(m) **Sedimentary Petrology.** CAROZZI, RICHARDS.
(n) **Stratigraphy.** LANGENHEIM, MANN.
(o) **Oceanography and Ocean Engineering.** RICHARDS.
(p) **Submarine Geology.** RICHARDS.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Geomorphology.** The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. 1 unit. Prerequisite: Geology 102. SHAFFER, White.

311. **Structural Geology.** Rock deformation and its results. Lectures, laboratory, and one two-day field trip. 1 unit. Prerequisite: Geology 102; General Engineering 205 or consent of instructor.

315. **Field Methods.** Mapping of an area in southern Illinois or western Kentucky during Easter vacation. Credit is given only on completion of a satisfactory written report. ½ unit. Prerequisite: Geology 102.

317. **Field Geology in the Rocky Mountains.** Field course conducted from a locality in the Rocky Mountains. Field training in stratigraphy, structure, and geomorphology; geologic mapping with a plane table and aerial photographs. Approximate cost, $325 to $470. S; 2 units. Prerequisite: Geology 102; consent of instructor.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lectures and laboratory. A student may not receive credit for both Geology 222 and 320. 1 unit. Prerequisite: Geology 102. HAY.

321. **Stratigraphy.** Stratigraphy-fossil faunas, with special reference to invertebrates, correlation, and stratigraphy. A student may not receive credit for both Geology 222 and 321. 1 unit. Prerequisite: Geology 320.

324. **Vertebrate Paleontology.** Same as Zoology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Geology 102 or Zoology 132. BADER.

325. **Paleobotany.** Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor.

335. **Optical Mineralogy.** Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is placed on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. 1 unit. Prerequisite: Geology 132. CHAPMAN.

336. **Petrography.** Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is placed on the ordinary methods of petrographical investigation. 1 unit. Prerequisite: Geology 335. CHAPMAN.

350. **Theoretical Geophysics.** An introduction to the major fields of theoretical geophysics: figure of the earth, thermodynamics of the earth, gravity, seismology, magnetism, and planetary geophysics. 1 unit. Prerequisite: Mathematics through calculus; one year of physics; Geology 311; consent of instructor.

351. **Geophysical Prospecting.** Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor. DE WITTE.

370. **Oceanography.** Principles of biological, chemical, geological, and physical marine science. 1 unit. Prerequisite: Botany 100 or Zoology 104, Chemistry 101, Geology 101, Physics 101; or consent of instructor. RICHARDS.

GERMANIC LANGUAGES AND LITERATURES

(Including German and Scandinavian)

The Department of Germanic Languages and Literatures offers work leading to the Master of Arts and Doctor of Philosophy. Students applying for admission must have a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Students should have completed a four-year course of undergraduate study in German corresponding to that of this University. They should be familiar with the principal works of the writers of the classical and modern periods of German literature, possess a general

knowledge of the history of German letters and civilization, and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is highly desirable. A reading knowledge of French is required for advanced graduate work. A reading knowledge of one additional language, to be determined on the basis of the candidate's research needs, is required for admission to the third year of graduate study.

Fields of concentration for advanced degrees include German philology and linguistics, older literature, and modern literature.

Candidates for the Master of Arts in the Teaching of German must earn four units in German, two units in education, and two units in electives. Requirements are: German, two or two and one-half units to be chosen from German 301, 302, 311, 312, 320, 331, 332, 415, or 420; one and one-half to two units from German courses open only to graduates; education, two units, including two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The electives must be selected with the approval of the adviser. See pages 41 and 42.

GRADUATE FACULTY

Professors: H. G. Haile (Head of Department), J. R. Frey, P. M. Mitchell, E. A. Philippson, H. Stegemeier.

Associate Professors: Ruth E. Lorbe, F. J. Nock.

Assistant Professors: H. Knust, J. McGlathery, Pauline S. Schwalbe.

German

COURSES FOR GRADUATES

400. **Beginning German for Graduate Students.** Introduction to the reading of German texts in the sciences and the humanities. No graduate credit. Schwalbe.

401. **Readings in German for Graduate Students.** Designed for graduate students preparing for the German reading requirements for the Ph.D. No graduate credit. Prerequisite: German 400 or equivalent. Schwalbe.

411. **Proseminar.** Methods of literary criticism and research. 1 unit. Staff.

415. **Middle High German.** 1 unit. Nock.

416. **Middle High German Literature.** 1 unit. Prerequisite: German 415 or equivalent. Nock.

420. **History of the German Language.** 1 unit. Philippson.

426. **Gothic.** An introduction to Germanic (comparative) linguistics. 1 unit. Offered in 1967-1968 and in alternate years.

431. **German Literature of the Middle Ages.** German literature from 800 to 1400. 1 unit. Offered in 1967-1968 and in alternate years. Philippson.

432. **German Literature from 1400 to 1700.** Renaissance, Reformation, and Baroque in German literature. Lectures and readings. 1 unit. Offered in 1967-1968 and in alternate years. Philippson.

441. **German Romanticism.** 1 unit. Offered in 1967-1968 and in alternate years. Mitchell.

442. **Nineteenth-Century German Realism.** 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: German 301 and 302 or equivalent. Frey.

445. **Old High German.** Grammar and interpretation of the oldest literary documents. 1 unit. Offered in 1968-1969 and in alternate years. Philippson.

451. **Naturalism, Symbolism, Expressionism.** German literature from the 1880's to the 1920's. 1 unit. Offered in 1968-1969 and in alternate years. FREY.

452. **German Literature from the Twenties to the Present.** 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: German 301 and 302, or equivalent. FREY.

460. **Seminar in Older German Literature.** 1 to 2 units. STAFF.

461. **Seminar in Modern German Literature.** 1 to 2 units. Prerequisite: German 411 and 495.

462. **Seminar in Germanic Philology and Linguistics.** 1 to 2 units. Prerequisite: German 411 and 495.

493. **Research in Special Topics.** ¼ to 2 units; may be repeated for a maximum of 2 units.

495. **Bibliography and Methods of Literary History.** To be taken concurrently with German 411. ½ unit. FREY.

499. **Thesis Research.** 0 to 4 units. FREY, HAILE, MITCHELL, PHILIPPSON, STEGEMEIER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **German Literature to 1700.** ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

302. **German Literature Since 1700.** ¾ unit. Prerequisite: German 210 and one other course in German literature. FREY.

303. **Advanced Conversation, Composition, and Syntax.** Extensive study of advanced problems of grammar, syntax, and style. ½ unit. Prerequisite: Three years of college German including German 212, or consent of instructor.

304. **Advanced Conversation.** Practice in free conversation with native speaker. No graduate credit. Prerequisite: German 303 or equivalent.

305. **Modern German Poetry.** A political and metrical survey of modern German lyric verse. ¾ unit. Prerequisite: German 210 and one other literature course or its equivalent, or consent of instructor.

307. **The Structure of the German Language.** Study of the structure of the German language with emphasis on contrastive syntax of English and German. ¾ unit. Prerequisite: German 210 and 212.

311. **Goethe.** Introduction to Goethe's life and works. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: German 210 and one other course in German literature. MITCHELL.

312. **Goethe's Faust.** Intensive study of Goethe's *Faust*, Parts I and II. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

320. **History of German Civilization.** A selected topical, historical, and pictorial analysis of German culture and civilization. ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

331. **The Age of Lessing.** ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

332. **Schiller.** ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

360. **Introduction to German Phonetics.** ½ unit. Prerequisite: Consent of instructor. NOCK.

382. **Language Laboratory Techniques.** Same as French, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-languages tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

392. **Topics in German Literature.** Intensive study of individual authors or other restricted topics in German literature. 1 to 2 units. Prerequisite: Two advanced courses in German literature.

Scandinavian

COURSES FOR GRADUATES

405. **Old Norse-Icelandic, I.** Grammar and selected readings. 1 unit. Offered in 1967-1968 and in alternate years. MITCHELL.

406. **Old Norse-Icelandic, II.** Readings. Selections from the Elder Edda and the sagas. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Scandinavian 405. MITCHELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. **Ibsen.** The dramas in English translation; selected works of Ibsen's Scandinavian contemporaries. 1 unit. Offered in 1967-1968 and in alternate years. MITCHELL.

362. **Strindberg and the Later Scandinavian Dramatists.** Major dramas and prose works of August Strindberg in translation; selected plays by Kaj Munk, Kjeld Abell, Nordahl Grieg, and Pär Lagerkvist. 1 unit. Offered in 1968-1969 and in alternate years. MITCHELL.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs renders advisory, consulting, and research services to the government of Illinois and their elected and appointed officials. Using the data acquired in these activities, the staff seeks, through scholarly and popular publication, to advance knowledge about the science of government and the political process.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of study leading to the Master of Science in Health Education. This program is centered in preparing teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for preparation in the special fields of public health education and safety education.

Admission requirements for a major in this field are: (1) a grade-point average of 3.75 (although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Requirements for the master's degree are eight units to include: (1) four units in health education or approved courses in physical education; (2) two units in education: History and Philosophy of Education 304 and 305, and Educational Psychol-

ogy 311 and 312; (3) satisfactory completion of Health Education 490, no credit; (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements but will be required to take two units' credit in lieu of thesis credit, and in addition, to pass a final comprehensive written examination in health education. See pages 41 and 42.

GRADUATE FACULTY

Professors: H. S. Hoyman (Head of Department), W. H. Creswell, Jr., A. E. Florio, W. J. Huffman, D. B. Stone.

Lecturers: C. A. Bridger, E. L. Wittenborn, Jr.

Health Education

COURSES FOR GRADUATES

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and principles as these apply to the further improvement of personal, family, and community health. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. Hoyman.

401. **Problems in School Health Education.** History, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. 1 unit. Creswell, Hoyman, Huffman.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. ½ or 1 unit. Stone.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. Hoyman, Huffman.

490. **Seminar.** Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. No credit. Staff.

493. **Special Projects.** Independent research. Open only to candidates for the Doctor of Philosophy. ½ or 1 unit. Prerequisite: Educational Psychology 390, Physical Education 495, and Health Education 400, or equivalent. Staff.

499. **Thesis Research.** Preparation of theses in health and safety education. ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to envioronment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. Shimkin, Staff.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. HOYMAN, LEVINE, STAFF.

390. **Public Health Education.** Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers; projects in preparing and using public health education materials; evaluation of research in public health education. ½ unit. Prerequisite: Consent of instructor. STONE.

391. **Public Health Statistics.** An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. ½ unit. Prerequisite: Mathematics 161 or Educational Psychology 390, or equivalent. BRIDGER.

Safety Education

COURSES FOR GRADUATES

402. **Problems in Safety Education.** Philosophy of safety: traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. 1 unit. FLORIO, HUFFMAN.

HISTORY

The Department of History offers work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work in history presupposes two years of undergraduate study in this subject, or a minimum of sixteen semester hours, including courses in European and American history. Undergraduate linguistic preparation, especially in French, German, or Russian, is important. For ancient, medieval, and renaissance history, some knowledge of Greek or Latin is essential. Spanish is useful for certain fields of European, American, and Latin-American history.

Admission to graduate study in history requires a grade-point average of at least 4.0 for the last sixty hours of undergraduate study. A student who has done graduate work in a recognized institution but without receiving a degree may petition to receive credit toward an advanced degree by passing examinations in this work.

Master of Arts. Candidates are expected to take at least two units in two of the fields of specialization for the Doctor of Philosophy listed below. A minimum of eight units is required for the Master of Arts and three of these units must be at the 400 level. The program must include two research seminars with grades of B or better. Students may elect to write a master's thesis, but the thesis does not replace the seminar requirement. A candidate must demonstrate ability to read one foreign language related to his fields of interest as approved by the graduate advisers.

Graduate study in history may also be pursued in connection with the Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see pages 338 and 339).

Doctor of Philosophy. The Department of History offers the following fields of specialization and preparation: ancient Greece; ancient Rome; medieval to 1300; Europe, 1300-1648 (Renaissance and Reformation); Europe and dependencies, 1648-

1815; Europe and dependencies since 1815; Russia; England to 1688; England and the Empire-Commonwealth since 1688; Near East and Middle East; China; Japan; South Asia; early America to 1789; United States since 1789; Latin America; History of Science.

A candidate must demonstrate ability to read two foreign languages related to his fields of interest as approved by the graduate advisers. A student who has not passed the examination in one language will not be readmitted to a second year of graduate study. No student is recommended for financial aid of any kind for a third year of study who has not passed both language examinations.

Two research seminars are normally required for all candidates if these were not taken here in the master's program. History 496 and 498 also are required. The doctorate requires a minimum of sixteen units beyond the master's degree. Eight of these may be thesis research credit.

Candidates must offer five fields of preparation for their preliminary examination; four in history and one in a related subject. The major field in which the thesis is to be written requires a minimum of four units; the first minor field, a minimum of three units; and the others, two units each. Fields other than those listed above may be accepted in individual cases.

The outside minor field may be arranged with the graduate advisers.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor, three units, in American literature, and a second minor, two units, in the history of fine arts in the United States.

Illinois Historical Survey. Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, students in history are able to obtain useful training in the study of manuscript as well as printed materials.

GRADUATE FACULTY

Professors: R. W. Johannsen (Chairman of Department), J. L. Bates, C. E. Dawn, R. T. Fisher, Jr., D. Geanakoplos, H. M. Hyman, C. E. Nowell, P. W. Schroeder, C. C. Spence, C. G. Starr, R. P. Stearns, R. M. Sutton.

Associate Professors: R. B. Crawford, R. M. McColley, J. A. Nichols, J. B. Sirich, W. U. Solberg.

Assistant Professors: B. D. Hill, B. B. Kling, T. A. Krueger, R. F. Kuisel, R. E. Mitchell, R. A. Waller, G. M. Wilson.

Instructor: B. P. Uroff.

COURSES FOR GRADUATES

403. Problems in Early Modern European History to 1815. 1 unit. Staff.

404. Problems in Modern European History Since 1815. 1 unit. Staff.

407. Problems in American History to 1865. 1 unit. Staff.

408. Problems in American History Since 1865. 1 unit. Staff.

411. Seminar in Ancient History: Greece. 1 unit. Mitchell, Starr.

413. Seminar in Ancient History: Rome. 1 unit. Mitchell, Starr.

415. Seminar in Medieval History. 1 unit. Geanakoplos.

417. Seminar in Renaissance and Reformation History. 1 unit. Geanakoplos.

419. Seminar in European History, 1648 to 1815. 1 unit. Sirich.

421. **Seminar in European History Since 1815.** 1 unit. Frank, Kuisel, McKay, Nichols, Schroeder.

423. **Seminar in English History to 1688.** 1 unit. Hill.

425. **Seminar in English and British Empire History Since 1688.** 1 unit.

427. **Seminar in Russian History.** 1 unit. Fisher, Uroff.

441. **Seminar in Near and Middle Eastern History.** 1 unit. Dawn.

443. **Seminar in South Asian History.** 1 unit. Kling.

445. **Seminar in East Asian History.** 1 unit. Crawford, Wilson.

451. **Seminar in Early American History to 1789.** 1 unit. Stearns.

453. **Seminar in American History Since 1789.** 1 unit. Hyman, Johannsen, Krueger, McColley, Solberg, Spence, Sutton, Waller.

461. **Seminar in Latin-American History.** 1 unit. Love, Nowell.

471. **Seminar in the History of Science.** 1 unit. Applebaum.

496. **History of Historiography.** Introduction to the great historians from early times to the present. 1 unit. Starr.

497. **Reading Course.** Directed reading in special fields. Open only to students with a master's degree or equivalent, who are preparing for the preliminary examination in history and who need instruction in areas not provided by current course offerings. 1 unit. Prerequisite: Master's degree or equivalent; consent of instructor. Staff.

498. **Problems in the Teaching of College History.** No credit. Prerequisite: Candidate for Ph.D. degree in history. Staff.

499. **Thesis Research.** Individual direction in research and guidance in writing theses for advanced degrees. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The general prerequisite for all graduate students registering in 300-numbered courses is one year of college history or consent of instructor.

301. **The Middle Ages from 400 to 1100 A.D.** Europe from the fall of Rome to the first crusade. ½ or 1 unit. Geanakoplos.

302. **The Middle Ages from 1100 to 1500 A.D.** Europe from the rise of towns to the establishment of national monarchy. ½ or 1 unit. Geanakoplos.

303. **History of Byzantine Civilization.** A study of cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D. to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. ½ or 1 unit. Geanakoplos.

304. **Medieval Civilization.** Religious and intellectual. ½ or 1 unit. Prerequisite: One year of college history or political science. Geanakopols.

305. **The Age of the Renaissance.** ½ or 1 unit. Geanakoplos.

306. **The Age of the Protestant and Catholic Reformation, 1500 to 1648.** ½ or 1 unit.

307. **Classical Islam: The Near East from Mohammed to the Crusades.** ½ or 1 unit. Dawn.

308. **The Europeanization of the Near East, 1768 to 1914.** ½ or 1 unit. Dawn.

309. **Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789.** ½ or 1 unit. Sirich.

310. **Development of Modern Europe: The French Revolution and Napoleon, 1789 to 1815.** ½ or 1 unit. SIRICH.

311. **European History from 1815 to 1871.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

312. **European History from 1871 to 1918.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

313. **European History from 1918 to 1939.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KUISEL.

314. **European History from 1939 to the Present.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KUISEL.

315. **Economic and Social History of Europe to 1750.** A history and analysis of the development of European economy and society from the Middle Ages to the Industrial Revolution; evolving agrarian systems; growth of commercial economies; industrial and technical progress; colonial expansion. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

316. **Economic and Social History of Europe Since 1750.** A comparative study of the Industrial Revolution in England, France, Germany, and Russia; social, cultural, and demographic consequences of rapid economic change; expanding world economy and modern imperialism. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

317. **Modern Italy, 1815 to the Present.** A survey of Italian political, social, economic, and cultural developments from the aftermath of the Napoleonic wars to the post-Second World War republic. ½ or 1 unit.

318. **Modern European Diplomatic History, 1789 to 1890.** The diplomatic history of Europe from the French Revolution to the fall of Bismarck. ½ or 1 unit. SCHROEDER.

319. **Modern European Diplomatic History, 1890 to the Present.** The diplomatic history of Europe from the fall of Bismarck to the present day. ½ or 1 unit. SCHROEDER.

320. **Russia from the Earliest Times to Peter the Great.** The political, economic, cultural, and social development of Russia during the Kievan and Muscovite periods. ½ or 1 unit. UROFF.

321. **Russia from Peter the Great to 1855.** The political, economic, cultural, diplomatic, and social development of Russia during Imperial times. ½ or 1 unit.

323. **Intellectual History of Modern Europe, 1513 to 1770.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

324. **Intellectual History of Modern Europe, 1770 to the Present.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

325. **Intellectual and Cultural History of Russia to 1881.** ½ or 1 unit. UROFF.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. UROFF.

327. **Russia from 1855 to the Bolshevik Revolution of 1917.** ½ or 1 unit. FISHER.

328. **History of Soviet Russia from 1917 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

329. **History of East Central Europe to 1815.** Survey of the political and cultural developments of the Western Slavs and their Baltic and Danubian neighbors, from the origin of the kingdoms of Poland, Bohemia, and Hungary to the Congress of Vienna. ½ or 1 unit.

330. **History of East Central Europe from 1815 to the Present.** The development of nationalism in East Central Europe since the Congress of Vienna; the Revolutions of 1848; the growth of nationalism and the struggle for independence; the establishment of national states; the First World War and Versailles; the interwar period; the Second World War and the Communist take-over. ½ or 1 unit.

332. **Medieval England.** Religious, social, intellectual, and economic developments in medieval England from the period of the Germanic invasions to the accession of the Tudors. ½ or 1 unit. HILL.

333. **Great Britain Under the Tudors and Stuarts, 1485 to 1660.** The principal political, economic, social, religious, and cultural developments in British history, including Scotland and Ireland, from the beginning of the Tudor dynasty to the Restoration of 1660. ½ or 1 unit.

334. **Great Britain Under the Later Stuarts and the Hanoverians, 1660 to 1815.** The principal political, economic, social, religious, and cultural developments in British history from the Restoration to the end of the Napoleonic wars. ½ or 1 unit.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and Economics 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics of American history. SCHWEITZER.

338. **History of Cosmology.** A history of man's changing conceptions of the structure and origin of the universe from the ancient creation myths to modern times. The relationships between cosmological theories and developments in the physical sciences, philosophy, religion, and social and cultural factors are explored. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor.

339. **History of the British Commonwealth in the Nineteenth Century, 1783 to 1900.** ½ or 1 unit.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** ½ or 1 unit.

341. **Modern Britain: The Victorian Era, 1815 to 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit.

342. **Modern Britain Since 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit.

345. **Constitutional History of England to 1485.** Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

346. **Constitutional History of England, 1485 to the Present.** Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

347. **The Emergence of Modern Science to the Age of Newton.** A history of science from ancient times to the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

348. **The History of Modern Science Since the Age of Newton.** The development of the sciences and scientific principles since the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

349. **The Scientific Revolution, 1543 to 1727.** A study of the birth of modern science in the seventeenth century, with special emphasis upon the rise of experimentalism, the growth of mathematical science, and the establishment of the mechanical philosophy. ½ or 1 unit.

350. **History of American Immigration to 1880.** The migrations which peopled the English colonies and the United States and their role in the shaping of American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

351. **History of American Immigration Since 1880.** Late nineteenth- and early twentieth- century migrations and their impact on American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

352. **Colonial Beginnings of American Life and Institutions.** A study of the seventeenth- and eighteenth-century colonies. ½ or 1 unit. STEARNS.

354. **The Era of the American Revolution, 1763 to 1789.** ½ or 1 unit. STEARNS.

355. **Federalists, Jeffersonians, and the Era of Good Feelings.** United States history from 1789 to 1828 with emphasis on the conflict between nationalism and sectional interests. ½ or 1 unit. MCCOLLEY.

356. **History of the United States, Jackson to the Civil War.** Study of Jacksonian democracy; the rise of sectionalsim; manifest destiny and the Mexican War; the issue of slavery and expansion and the approach of the Civil War. ½ or 1 unit. JOHANNSEN.

357. **Economic History of the United States, 1775 to 1860.** The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. ½ or 1 unit. SPENCE.

358. **Economic History of the United States Since 1860.** The growth of American economic life and institutions since 1860. ½ or 1 unit. SPENCE.

359. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. ½ or 1 unit. JOHANNSEN.

360. **History of the United States, 1877 to 1909.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics.

361. **History of the United States, 1909 to 1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics.

362. **History of the United States Since 1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics.

363. **Social History of Industrial America to 1890.** The impact of industrialization, immigration, and urbanization on American society in the nineteenth century. ½ or 1 unit.

364. **Social History of Industrial America Since 1890.** A study of the impact of industrial technology, business enterprise, immigration, and urbanization on American society. ½ or 1 unit.

365. **The History of Illinois to 1870.** Evolution of a typical midwestern commonwealth, with emphasis upon its political, economic, social, religious, and cultural development in the nineteenth century. ½ unit. SUTTON.

366. **The History of Illinois from 1870 to the Present.** The evolution of a modern American state, with emphasis upon its political life, economic growth, social and intellectual problems, and its contribution to the American nation. ½ unit. SUTTON.

367. **The Trans-Mississippi West.** The history of Western expansion since the Louisiana Purchase; the West in the general history of the United States; Western economic and political problems. ½ or 1 unit. SPENCE.

368. **History of the South.** An inquiry into the question, when did the South begin and what have been its distinguishing traits? Special attention is given to agrarianism, industrialization, and the race problem. ½ or 1 unit.

369. **Constitutional Development of the United States to 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science. HYMAN.

370. **Constitutional Development of the United States Since 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science. HYMAN.

371. **American Intellectual and Cultural History to 1877.** Social and political thought, religion, science, scholarship, and education as both results and causes of American experience. ½ or 1 unit. SOLBERG.

372. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. ½ or 1 unit. SOLBERG.

373. **Diplomatic History of the United States to the End of the Nineteenth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science.

374. **Diplomatic History of the United States in the Twentieth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science.

375. **History of Latin America to 1824.** A survey of Latin-American history from the discovery of America until 1824. ½ or 1 unit. NOWELL.

376. **Latin America Since 1824.** A history of the Latin-American republics from their independence to the present. ½ or 1 unit. NOWELL.

377. **History of Modern Brazil from 1808 to the Present.** An analysis of developments from 1808, emphasizing the advances and discontinuities in the growth of a neocolonial, agricultural society into an urban, industrial polity. ½ or 1 unit. Prerequisite: One year of college history or enrollment in Latin-American studies program. LOVE.

381. **Ancient Greek States.** History of the Greek states from the earliest times to 334 B.C. ½ or 1 unit. STARR.

382. **Alexander and His Successors.** ½ or 1 unit. STARR.

383. **History of the Roman Republic to 44 B.C.** ½ or 1 unit. MITCHELL.

384. **The Roman Empire.** ½ or 1 unit. MITCHELL, STARR.

387. **Indian History and Civilization to 1707.** Development of Indian civilization up to the British conquest. Political evolution; religious and philosophical systems; society, art, and literature during Hindu and Muslim periods. ½ or 1 unit. KLING.

388. **Development of Modern India and Pakistan from 1707.** Establishment and organization of the British Empire in India; reaction of India to the Western impact; growth of nationalism and the struggle for independence. ½ or 1 unit. KLING.

389. **Problems of Contemporary South Asia.** Current political, economic, social, and cultural problems of India, Pakistan, and Ceylon dealt with in the perspective of the historical development of South Asia. ½ or 1 unit. KLING.

391. **A History of China to 906 A.D.** A history of the formative period of the Chinese state, society, and economy. ½ or 1 unit. CRAWFORD.

392. **A History of China, 907 to 1840.** A history of the early modern Chinese state and society prior to the Western impact. ½ or 1 unit. CRAWFORD.

393. **Chinese Intellectual History from Earliest Times to the Present.** A study of the major ideas and schools of thought as they have affected the course of Chinese history and the development of its institutions. ½ or 1 unit. CRAWFORD.

394. **Modern China, China Since 1840.** A study of China's response to the Western impact, with special emphasis on the Nationalist revolution, and the rise of the Communist party of China and its domestic and foreign policies. ½ or 1 unit. CRAWFORD.

395. **Premodern Japan.** Japanese history from its origins to 1800; evolution of the traditional society, stressing institutional and cultural problems of the ancient, "feudal," and early modern (Tokugawa) period. ½ or 1 unit. WILSON.

396. **Modern Japan.** Japanese history since 1800; institutional and cultural problems connected with Western pressure, the Meiji Restoration, rise and fall of empire, and creation of a modern society. ½ or 1 unit. WILSON.

398. **Intellectual History of Japan.** Shinto, Buddhism, Confucianism, and Western thought as cultural and social forces in the evolution of Japan from its origins to the present. ½ or 1 unit. Prerequisite: One year of college history or philosophy. WILSON.

HOME ECONOMICS

The Department of Home Economics offers work leading to the Master of Science or Master of Arts in Home Economics; Master of Science in Home Economics Education; and Doctor of Philosophy in Home Economics with a major in foods and nutrition. The major work for a master's degree in home economics may be done in one of six curricula as shown below. The minimum grade-point average for admission to graduate study in home economics and home economics education is 3.75. Applications of students with averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science or Master of Arts. Candidates for a master's degree in home economics must complete a minimum of eight units (nine if a thesis is not submitted), of which at least four must be in home economics. Four of the total units, including at least two in home economics, must be in 400-level courses.

Lists of suggested electives for each curriculum are available from the department upon request. Required courses for each of the six curricula are given below:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 305, 410, 418, 419, and 499.

(2) *Family and Consumption Economics.* A minimum of four units from Home Economics 370, 379, 470, 499, with credit in Home Economics 370 and 499 required. A minimum of two units from Economics 300, 301, 400-401, or 402-403.

(3) *Family Housing and Household Management.* A minimum of nine units; two from Home Economics 361, 370, 375, 378, 379, and 470; Agricultural Engineering 300, and Architecture 339; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from Economics 313, Finance 369, Sociology 407, 476, 477.

(4) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499; also, Chemistry 354, or 350 and 355 are required.

(5) *General Home Economics.* A minimum of four units from prescribed courses in three of the other five curricula in home economics.

(6) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 395, 480, 487, and 499.

Candidates for the Master of Science in Home Economics Education must earn eight units, four of them in home economics. Three of the eight units must be in 400-numbered courses and at least one of these must be in home economics. Courses in home economics are to be chosen from Home Economics 301, 320, 322, 323, 326, 330, 331, 361, 375, 378, 379, 380, 386, 388, 395, 410, 418, 419, 480, and 487; Educational Psychology 311 and 312, one unit; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; Vocational and Technical Education 453, one unit; Vocational and Technical Education 456, one unit, or Home Economics 377, one-half to one unit. See pages 41 and 42.

Doctor of Philosophy. Candidates for this degree with a major in foods and nutrition must present an undergraduate foods course with an organic chemistry prerequisite; a nutrition course with organic chemistry and physiology prerequisites; adequate training in chemistry, including quantitative analysis and organic; and introductory courses in microbiology, physics, and trigonometry. A student emphasizing foods in the doctoral program should have had a course in colloid chemistry. Deficiencies in these requirements may be made up during the first year of graduate study.

Required courses include at least three units of foods and nutrition, two at the 400 level; one unit of statistical methods at the 400 level; courses in biochemistry and physical chemistry; and an advanced course in food microbiology or mammalian physiology. Additional courses in the above areas or in animal nutrition or food science are selected to satisfy major unit requirements. Candidates may minor in animal nutrition, biochemistry, food science, microbiology, physiology, and other appropriate areas. Either foods or nutrition is emphasized in research for the thesis.

Graduate students who choose an area of home economics as a minor for the Doctor of Philosophy must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in 400-level courses.

GRADUATE FACULTY

Professors: Janice M. Smith (Head of Department), Marilyn M. Dunsing, Ruth L. Galbraith, Pearl Janssen, Frances Van Duyne.

Associate Professors: Mildred Bonnell, Margaret Goodyear, Beulah Hunzicker, Glenna H. Lamkin, Queenie B. Mills, Willie Mae Mowrer, Lorraine D. Trebilcock.

Assistant Professors: Karlyne Anspach, Esther L. Brown, Beula V. McKey.

COURSES FOR GRADUATES

410. Problems in Family Living. Family relationships and their significance to the growth of family members. 1 unit. Prerequisite: Home Economics 210. Mowrer.

418. Seminar in Child Development. Advanced problems in child development. 1 unit. Prerequisite: Home Economics 301. Mowrer, Van den Daelen.

419. Seminar in Family Relationships. Critical evaluation of research literature in the field of marriage and family relationships. 1 unit. Prerequisite: Home Economics 410. Mowrer.

422. Seminar in Nutrition. A study of recent literature in nutrition. ½ or 1 unit. Prerequisite: Undergraduate degree in home economics, with emphasis on foods and nutrition, or comparable background in biochemistry, microbiology, physiology, or other biological science.

423. Problems in Human Nutrition. Methods of assessing nutritional status of humans. ½ or 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Home Economics 324 or equivalent.

430. **Carbohydrates in Foods.** Same as Food Science 430. A study of the physical and chemical properties of carbohydrates used in food and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 354 or 350 and 355, or consent of instructor.

432. **Seminar in Foods.** Review of current literature in foods research. ½ or 1 unit. Prerequisite: Undergraduate major in foods and nutrition, chemistry, microbiology, or physiology; consent of instructor. Van Duyne.

470. **Seminar in Family and Consumption Economics.** Same as Agricultural Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in applied statistics; Home Economics 313, 370, or consent of instructor. Dunsing.

480. **Seminar in Textiles.** Current literature related to development in the production, use, and care of textile fabrics. ½ or 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. Galbraith.

487. **Seminar in Clothing.** Study and discussion of research in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. ½ or 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. Anspach.

493. **Advanced Studies in Home Economics.** Library or experimental research on specific problems of limited scope. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. This is one of the courses which may be taken in addition to eight units required for a master's degree by students who do not write a thesis. ½ or 1 unit. Staff.

499. **Thesis Research.** Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. 0 to 4 units. Dunsing, Galbraith, Mills, Mowrer, Smith, Van Duyne.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. ½ or 1 unit. Prerequisite: Home Economics 202 and 203; consent of instructor. Mowrer.

305. **Human Heredity.** Heredity in man and its relation to various individual and social problems. Lectures, discussions, and demonstrations. Graduate credit does not count toward a major in genetics. ½ unit.

313. **Economics of Consumption.** Same as Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. Dunsing.

320. **Diet in Disease.** ½ unit. Prerequisite: Home Economics 220. Brown.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. ½ unit. Prerequisite: Home Economics 220; consent of instructor. Brown.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition. Readings, lectures, and discussions. S; ½ unit. Prerequisite: Chemistry 132 or 133; Physiology 103; Home Economics 220 and 231. McKey, Van Duyne.

324. **Problems in Nutrition.** Discussions and investigations. ½ or 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing. NORDSTROM.

326. **Presentations: Principles and Techniques.** Selection of problems and organization of materials for demonstrations and other presentations in home economics subject matter areas. Field trip; estimated cost, $15.00. ½ unit. Prerequisite: Senior standing; consent of instructor. LAMKIN.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. ½ or 1 unit. Prerequisite: Home Economics 231; Microbiology 100 and 101. JANSSEN.

331. **Problems in Foods.** Individual problems in food preparation and preservation. ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. **Institution and Restaurant Management: Food Purchasing and Equipment Selection.** Purchasing food and selecting equipment for quantity food service; factors affecting the purchase of food, relationship of floor plans and equipment to lets. Field trip; estimated cost, $10.00. ½ unit. Prerequisite: Advertising 281; Home Economics 345 and 351. Prerequisite: Credit or registration in Home Economics 240; Economics 108. BONNELL.

350. **Institution and Restaurant Management: Organization and Administration.** The organization and administration of food service operations; management problems in various types of food service, personnel, costs, sanitary control. Field trips; estimated cost, $20.00 to $25.00. ½ or 1 unit. Credit is not given for both Home Economics 350 and 351. Prerequisite: Home Economics 220 and 240. HUNZICKER.

351. **Special Problems in Group Feeding.** For individuals interested in refreshing and strengthening knowledge in group feeding. Lectures, discussions, laboratory practice in quantity food management. Food handler's certificate required. No credit for students who have completed Home Economics 240, 345, or 350. S; ½ unit. Prerequisite: Home Economics 220 and 231, or equivalent; consent of instructor. BONNELL.

355. **Specialized Quantity Food Production and Management.** Advanced application of food production and management principles to special food service demands. Emphasis on artistry in preparation, serving, and merchandising high quality food in quantity. ½ unit. Prerequisite: Home Economics 240, credit or registration in Home Economics 350, or consent of instructor. BONNELL.

361. **Development and Function of Family Housing.** Same as Agricultural Mechanization 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ¾ unit. Prerequisite: Home Economics 160 and 171, or consent of department. HANSEN.

370. **Family Economics.** Same as Agricultural Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. ½ unit. Prerequisite: Home Economics 171; six advanced hours in home economics, including one of the following: Home Economics 231, 273, 380; consent of instructor.

377. **Cooperative Extension: Home Economics.** The philosophy, history, and organization of the cooperative extension service. Consideration of program develop-

ment, methods of presentation, and evaluation with emphasis on socio-economic characteristics of state and county. ½ to 1 unit. Prerequisite: Economics 108; Psychology 100 and Sociology 100, or Educational Psychology 211, or Agriculture 206; consent of instructor. DUNLAP.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the fields of family housing, home furnishings, and home management. ½ to 1 unit. Prerequisite; Home Economics 262 or 270; consent of instructor. ALEXANDER, GOODYEAR.

379. **Problems in Family and Consumption Economics.** Individual investigation of specific problems in the field of family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

380. **Advanced Textiles.** The effect of the physical and chemical structures of textile fibers on their properties, manufacturing processes, use, and care. 1 unit. Prerequisite: Home Economics 183; Chemistry 102 or 132. GALBRAITH.

386. **Clothing Design: Draping.** Designing by draping, inspired by appropriate design sources; understanding of fitting principles through fabric manipulations; design effects maintained in garment construction. 1 unit. Prerequisite: Home Economics 285 or consent of instructor; Home Economics 286. ANSPACH.

388. **Problems in Textiles and Clothing.** Investigation and report of individual problems in the field of textiles and clothing. ½ or 1 unit. Prerequisite: Home Economics 286 or 380 or Marketing 211; consent of instructor. ANSPACH, GALBRAITH, TREBILCOCK.

395. **Fashion Analysis.** A study of fashion terminology, selected designers, garment manufacturing techniques, and methods of fashion promotion used in retail outlets. Field trip; estimated cost, $10.00. ½ unit. Prerequisite: Advertising 281; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosphy degrees. Students may specialize in any phase of horticulture including genetics, physiology, ecology, developmental anatomy, or marketing. Apiculture is offered jointly with the Department of Entomology. Well-equipped laboratories and extensive experimental farms are available for each area of specialization within the department. Special facilities available on campus include the computer laboratory, electronmicroscope laboratory, and radiocarbon laboratory. A well-balanced program may be achieved by taking courses in agronomy (crops or soils), botany, food science, genetics, statistics, plant pathology, chemistry, biochemistry, entomology, or agricultural economics. Students may minor in any of these fields.

Applicants with a grade-point average of 4.0 or above for the last sixty semester credit hours of course work for the bachelor's degree are admitted for graduate study in horticulture. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Applicants should have adequate preparation in the fundamental sciences.

A minimum of eight units must be completed for the master's degree. A candidate for the degree of Doctor of Philosophy must complete eight units of courses beyond the master's degree, satisfy the language requirements, and pass an oral preliminary examination. The candidate must also complete eight units of thesis research and submit an acceptable thesis.

Additional information concerning specific requirements and opportunities in graduate research is available from the Head of the Department of Horticulture, 125 Mumford Hall.

GRADUATE FACULTY

Professors: C. J. Birkeland (Head of Department), C. Y. Arnold, J. R. Culbert, D. F. Dayton, J. B. Gartner, M. B. Linn, R. V. Lott, J. P. McCollum, D. Powell, R. K. Simons, A. E. Thompson, J. S. Titus, J. S. Vandemark.

Associate Professors: H. C. Barrett, E. R. Jaycox, A. M. Rhodes.

Assistant Professors: L. Beevers, J. D. Butler, D. B. Dickinson, T. K. Hodges, H. J. Hopen, M. M. Meyer, W. E. Splittstoesser, C. C. Zych.

COURSES FOR GRADUATES

424. Mineral Nutrition of Plants. Same as Agronomy and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. Hageman.

440. Design and Analysis of Biological Experiments, I. Same as Agronomy, Animal Science, Dairy Science, Forestry, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. Design and Analysis of Biological Experiments, II. Same as Agronomy, Animal Science, Dariy Science, Forestry, and Veterinary Medical Science 441. A continuation of Horticulture 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Horticulture 440 or equivalent.

447. Horticulture Seminar. Discussion of current research and literature pertaining to problems of horticulture and related fields. ¼ unit. Staff.

490. Research Methods in Horticulture. Lectures, discussions, demonstrations, and laboratory exercises dealing with methods and apparatus used in horticultural research. 1 unit. Prerequisite: Chemistry 133 or equivalent; Chemistry 122 or equivalent; Botany 330; five hours of physics. Staff.

492. Special Topics in Horticulture. Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. ½ to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

499. Thesis Research. Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. Floricultural Physiology. A study of the physiology and metabolism of floricultural crops during their development from seeds through flowering. Lectures and discussion. 1 unit. Prerequisite: Botany 230 and 231, or equivalent; one semester of organic chemistry. Beevers.

322. Plant Nutrition. A study of the mechanisms of and factors affecting the absorption, transport, and functions of the essential elements required by higher plants. Lectures, discussions, and laboratory. 1 unit. Prerequisite: Botany 230 and 231, or equivalent; one semester of organic chemistry. Hodges.

323. **Priniciples of Plant Breeding.** Same as Agronomy 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, the maintenance of high quality seed stocks. Field trips; estimated cost, $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. Hadley, Hittle, Thompson.

335. **Economics of Food Distribution.** Same as Agricultural Economics 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. Kelly.

345. **Growth and Development of Horticultural Crops.** Factors affecting growth, development, and quality of vegetable crops. Lecture and discussion. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Botany 230 or equivalent, or consent of instructor. McCollum.

361. **Individual and Group Behavior of Honey Bees.** Same as Entomology and Zoology 361. Study of individual and group behavior of honey bees, their biological value, physical basis, and evolution. Lectures and discussions, one or more local field trips, term paper, and assigned reading. ½ unit. Prerequisite: One semester of entomology or zoology. Jaycox.

HUMANITIES

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Comparative Literature, I.** A comparative study of great books in Greek, Roman, Italian, and Spanish literature. ½ unit.

364. **Introduction to Comparative Literature, II.** A comparative study of great books in French, German, and Russian literature. ½ unit.

INDUSTRIAL ADMINISTRATION

The Department of Industrial Administration offers graduate work either as a major or a minor leading to the Master of Science in management, and as a minor for the Doctor of Philosophy.

Admission requires a grade-point average of 3.75 for the last sixty hours of undergraduate study. Candidates with a grade-point average between 3.5 and 3.75 may be considered on an individual basis. Such students may be required to take an appropriate examination such as the Admission Test for Graduate Study in Business (fee $10.00).

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration and related subjects. To do minor work in this field, at least twelve hours of work in business administration and related subjects are required.

GRADUATE FACULTY

Professors: P. M. Dauten, Jr., P. M. Green, E. G. Planty, P. C. Roberts.

Associate Professors: D. M. Slate (Acting Head of Department), R. L. Black, R. N. Corley, D. R. Day, B. F. Kirkpatrick, H. J. Zimmermann.

Assistant Professor: H. Hinomoto.

COURSES FOR GRADUATES

401. **Scientific Management, I.** Same as Industrial Engineering 401. A study of modern management principles on the basis of quantitative methods, concentrating on such operation research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor.

402. **Scientific Management, II.** Same as Industrial Engineering 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of operation research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Industrial Administration or Industrial Engineering 401; background in computer technology or consent of instructor.

416. **Problems in Business Policy.** Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. 1 unit. Prerequisite: Consent of instructor.

448. **Problems of Personnel Management.** Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. This course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contracts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 351 or equivalent, or consent of instructor.

449. **Problems of Personnel Management.** Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Industrial Administration 351, 448, or equivalent.

491. **Seminar in Special Topics.** For lectures in topics of current interest not covered by regular course offerings. Subjects will be announced in the Time Table. ¼ to 1 unit. Prerequisite: Consent of instructor or department head.

499. **Thesis Research.** 1 unit. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Business Torts.** Liability of businessmen for their wrongful acts and those of their agents arising separate and apart from their liabilities under contracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, including breach of contract. ¾ or 1 unit. Prerequisite: Industrial Administration 200; senior standing.

301. **The Law of Security Transactions and Banking.** Significant phases of law in the fields of pledges, chattel mortgages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. ¾ or 1 unit. Prerequisite: Industrial Administration 200; senior standing.

302. **Wills, Estates, and Trusts.** A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. ¾ or 1 unit. Prerequisite: Industrial Administration 200; senior standing.

311. **Administrative Policies and Organization.** Development of administrative organization and the determination of policies for the integration of major activities of a business enterprise. ½ or ¾ unit. Prerequisite: Industrial Administration 210; Marketing 201.

315. **Management in Manufacturing.** Internal problems of production and efficient control in factories. ½ unit. Prerequisite: Industrial Administration 210.

321. **Industrial Social Systems, I.** Same as Labor and Industrial Relations 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations between union and management; the interdependency of these factors with the decisions managers make. ½ to 1 unit. Prerequisite: Industrial Administration 210; Psychology 100; Psychology 201 or consent of instructor.

323. **Industrial Social Systems, II.** Understanding of complex organizations; particular attention to ways of dividing work, achieving coordination, and issues connected with change and adaptation. ½ to 1 unit. Prerequisite: Industrial Administration 321; Psychology 201.

351. **Personnel Administration.** A study of concepts and methods used by the staff personnel unit in building and maintaining an effective work force in an industrial organization; development of ability to design the personnel subsystem within the firm and to deal effectively with problems encountered in such areas as recruitment, selection, training, and wage and salary administration; considerable emphasis upon case analysis, role playing, and research. Credit is not given for Industrial Administration 351 and Psychology 145 or 245 and Industrial Administration 448 or 449. ½ to 1 unit. Prerequisite: Economics 173 and 240; Industrial Administration 323.

353. **Industrial Relations Administration.** An investigation of union-management relations primarily at the company level for those planning careers in the industrial labor relations field; topics include grievance handling, disciplinary policies and procedures, arbitration and contract negotiations; emphasis is given to case study and role playing techniques. Credit is not given for both Industrial Administration 353 and Industrial Administration 448 or 449. ½ to 1 unit. Prerequisite: Industrial Administration 323; Economics 240.

JOURNALISM

The Department of Journalism offers graduate work leading to the Master of Science in Journalism. For the program leading to the Doctor of Philosophy in Communications, see page 118.

Admission to graduate work in journalism requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in journalism or a related field such as English or the social sciences; and (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Requirements for the master's degree include:

(1) A major of four units, or three units and one additional unit approved by the department. Candidates without acceptable undergraduate majors may be required to complete (a) one unit of Journalism 321, (b) one unit of advanced undergraduate courses in writing or editing, and (c) in individual cases, some combination of Journalism 204, 211, 223, and 291, without graduate credit.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A thesis of one unit (Journalism 499) or the preparation of a topic of general public interest for publication or broadcast (Journalism 490).

(4) A minimum of three units in courses at the 400 level, at least two of which must be in the major field.

(5) A comprehensive written examination in the student's major and minor fields and on the current master's reading list.

(6) A minimum total of eight units.

GRADUATE FACULTY

Professors: J. W. Jensen (Head of Department), T. Peterson.

Associate Professors: G. G. Hanson, H. S. Maclay, J. H. Schacht.

Assistant Professors: J. W. Carey, T. A. Guback.

COURSES FOR GRADUATES

468. The Political Economy of Communications. Same as Communications 468. Analysis of the structure, policy, and behavior of such media of communication as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. Guback.

470. Communications and Popular Culture. Same as Communications 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit.

471. Proseminar in Communications, I. Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control, and support; content, audience, and effect of the mass media. 1 unit. Carey, Staff.

472. Proseminar in Communications, II. Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. Maclay, Staff.

473. History and Theory of Freedom of the Press. Same as Communications 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. Jensen.

474. Communications Systems. Same as Communications 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. Carey.

490. Special Topics in Journalism. ½ or 1 unit. Prerequisite: Consent of head of department. Staff.

492. Research Methods in Communications. Same as Communications 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. Wiggins.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in journalism. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. High School Journalism. Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and

publicity; junior college courses in journalism. ½ unit. Prerequisite: History and Philosophy of Education 201 or consent of instructor. GILMORE.

311. **Law and the Press.** The historical background of the nature and meaning of the law as it relates to journalism and contemporary problems of freedom of expression. ½ unit.

321. **News Editing.** Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and make-up and design of newspaper pages. 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212 or consent of instructor. GILMORE, PUFFENBARGER, SCHACHT.

323. **Advanced Reporting.** Advanced types of news investigation and treatment. ½ unit. Prerequisite: Journalism 211 and 212, or equivalent. PUFFENBARGER.

326. **Magazine Article Writing.** Preparation of feature stories and articles; techniques of marketing, market analysis, and publishing articles written in the course. ½ unit. Prerequisite: Journalism 211 or consent of instructor. GRAHAM, SCHACHT.

327. **Special Topics in Twentieth-Century Journalism.** Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. ½ unit. Prerequisite: Journalism 211 or consent of instructor.

329. **The Rhetoric of Journalism.** Studies in journalistic method, involving principally the analysis of structure and writing style as related to purpose. Materials are drawn from English and American journalism from the seventeenth century to the present, but emphasis is on work published in twentieth-century American newspapers and periodicals. ½ unit. Prerequisite: Journalism 211 or consent of instructor. SCHACHT.

330. **Magazine Editing.** Basic principles of editing for consumer, business, trade, and company magazines; communications theory, market analysis, editorial process, design process, production process, and distribution process as they relate to magazine publishing. ½ unit. Prerequisite: Credit or registration in Journalism 326. SCHACHT.

341. **Newspaper Management.** Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circulation, and commercial printing departments; plant operation. ½ unit. Prerequisite: Credit or registration in Journalism 204.

344. **Community Newspaper Publication.** Study of weekly and small- and medium-sized daily newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. ½ unit. Prerequisite: Journalism 212 or consent of instructor. GILMORE.

372. **Social Aspects of Mass Communications.** Same as Communications and Sociology 372. Media structures related to cultural content and functions. Problems of life and society as treated in mass-produced communications. ½ unit. GUBACK.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a Master of Arts and a Doctor of Philosophy in Labor and Industrial Relations. Graduate instruction is offered in trade union and management organization, in the accommodation of these organizations through the process and structure of collective bargaining, in personnel administration and employee relations, in the role of the government in legislating labor standards and labor relations, and in the formulation of public policy. These matters are studied in the context of social, economic, and political change and are

analyzed with the help of theoretical and empirical formulations of economics, history, law, political science, psychology, and sociology.

Master of Arts. A student seeking admission to the Institute's master's program must meet the general entrance requirements of the Graduate College. In addition, the faculty reviews the undergraduate record of every candidate and may refuse admission to a student whose record indicates inadequate preparation. Prerequisites are courses in labor problems and statistics; course work in the various social sciences is desirable preparation for the Institute program.

Candidates for the master's degree have a choice of study programs. Program A requires eight units of graduate credit, two of which are granted for successful completion of a thesis. Program B requires ten units of course work and successful completion of both written and oral comprehensive examinations.

Doctor of Philosophy. Admission to the doctoral program is granted only to those students whose undergraduate and graduate records indicate that they are likely to complete successfully the requirements for the Ph.D. Admission requirements are a master's degree or equivalent in labor and industrial relations or an allied field, a master's thesis or similar evidence of research competence, a grade-point average of at least 4.2, and three letters of recommendation. Prerequisites are courses in labor problems, statistics, and college algebra; first-year calculus is recommended. Minimum preparation in the social sciences is an undergraduate major in economics, history, political science, psychology, or sociology, or at least nine hours in each of two social sciences. All students entering the Ph.D. program are regarded as provisional candidates until they have passed the oral qualifying examination.

The candidate's course work is concentrated in two or more social science disciplines related to a selected area of specialization; in addition, five units of course work in industrial relations theory and methodology are required. The candidate may select one of the following four areas for specialization: (1) industrial relations systems and public policy; (2) wages, labor market behavior, and income security; (3) labor and management organizations and labor-management relations; (4) interpersonal and intergroup behavior.

Students taking master's or doctoral degrees in other departments—economics, industrial administration, communications, history, political science, psychology, sociology, and others—may arrange a minor in labor and industrial relations.

Full details of the Institute program and requirements are given in the publication, *Graduate Study at the Institute of Labor and Industrial Relations*, which may be obtained by writing to the Institute of Labor and Industrial Relations,

GRADUATE FACULTY

Professors: M. Wagner (Director of the Institute of Labor and Industrial Relations), W. E. Chalmers, M. Derber, P. L. Garman, J. R. Gusfield, B. Karsh, S. B. Levine, W. McPherson, A. F. Sturmthal, H. C. Triandis.

Associate Professors: H. Folk, W. H. Franke, M. Rothbaum, V. L. Stoikov.

Assistant Professors: P. T. Hartman, C. L. Hulin.

COURSES FOR GRADUATES

418. Seminar in Industrial and Economic Sociology. Same as Sociology 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Labor and Industrial Relations 318 or consent of instructor. Karsh, Phillips.

420. Formation of Public Policy. Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its

administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. 1 unit. HAGAN.

435. **Motivation and Morale in Industry.** Same as Psychology 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. TRIANDIS.

440. **Labor Economics.** Same as Economics 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

441. **Labor Economics.** Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics. MCNATT.

442. **Collective Bargaining.** Same as Economics 442. The development of a theory of the continuing interactions between union and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. 1 unit. Prerequisite: Consent of instructor.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling; analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. MCPHERSON.

444. **Economics of Manpower Resources.** Same as Economics 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. PARRISH.

446. **Foreign and International Labor Movements.** History and organization, economic and political policies of the major labor movements in the world; their international organizations; comparative analysis of particular problems confronting these movements; labor movements in underdeveloped areas; labor and economic development; labor under totalitarian regimes. 1 unit. Prerequisite: Consent of instructor. STURMTHAL.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. GARMAN.

448. **Problems of Personnel Management.** Same as Industrial Administration 448. An examination of the organization and administration of the personnel function

in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 248 or equivalent, or consent of instructor.

449. **Problems of Personnel Management.** Same as Industrial Administration 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Labor and Industrial Relations 448 or equivalent.

450. **Management and Industrial Relations.** An analysis of the industrial relations function in management. Using case problems, research reports, and theoretical analyses, an examination is made of the development of the industrial relations function, alternate organizational approaches in dealing with employees and unions, the formation of labor relations policies, and management responsibilities in industrial relations. 1 unit. Prerequisite: Consent of instructor.

490. **Individual Topics.** A student in labor and industrial relations may register for this unit with the consent of his curriculum adviser and the adviser under whom he will perform the individual study or research. Such individual work may include special study in a subject matter for which no course is available or an individual research project, including on-the-job research in industry, which is not being undertaken for a thesis. 0 to 2 units. STAFF.

492. **Readings in Labor and Industrial Relations.** Readings and analysis of important works in the field of industrial relations. The course is designed to emphasize the differing but complementary approaches of several social sciences to industrial relations problems. The interdisciplinary approach is sought both through selection of readings and through the participation of various Institute staff members in discussions dealing with their special interests. 1 unit. Prerequisite: Consent of instructor.

493. **Research Seminar in Labor and Industrial Relations.** Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, FRANKE.

494. **The Major Theorists of Industrial Relations.** An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. 1 unit. Prerequisite: Consent of instructor. DERBER.

496. **The Evolution of Labor-Management Relations in America.** Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. 1 unit. Prerequisite: Graduate standing in labor and industrial relations or consent of instructor. DERBER.

498. **Analysis of Organizations in Industrial Relations.** An intensive analysis of organizational behavior, with the main focus upon the theory of organizations as social institutions. Concepts are drawn from the various social sciences and applied to the principal organizations concerned with industrial relations. The internal dynamics of unions, managements, and government agencies are examined, with special

reference to decision-making processes, and are related to the interactions among them. 1 unit. Prerequisite: Consent of instructor. LEVINE.

499. **Thesis Research.** For all students writing theses in labor and industrial relations. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

318. **Industry and Society.** Same as Sociology 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH, PHILLIPS.

321. **Industrial Social Systems, I.** Same as Industrial Administration 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations between union and management; the interdependency of these factors with the decisions managers make. ½ to 1 unit. Prerequisite: Industrial Administration 210; Psychology 100; Psychology 201, or consent of instructor.

342. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108. MCNATT.

344. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240. MCNATT.

347. **Labor Law, I.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; the establishment of the collective bargaining relationships; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit.

355. **Industrial Social Psychology.** Same as Psychology 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid to understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or Labor and Industrial Relations 357. TRIANDIS.

357. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN.

360. **Employee Benefit Plans.** Same as Finance 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans, and to "qualified" pensions and profit-sharing plans for regular employees; some attention is given to special, supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 351; or consent of instructor.

365. **Government and Labor.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting

labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

LANDSCAPE ARCHITECTURE

The Department of Landscape Architecture offers work leading to the Master of Landscape Architecture degree. Students applying for admission must have a grade-point average of at least 3.75.

The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture or related fields of study. Those students whose undergraduate major is not substantially equivalent to the degree in landscape architecture conferred by the University of Illinois must expect to complete prerequisite courses before taking advanced work in landscape architecture.

To qualify for this degree, a student must complete (1) at least six units of graduate credit in required courses in landscape architecture, (2) at least two additional units to be chosen from the following fields: architecture, art, botany, civil engineering, forestry, geography, geology, horticulture, recreation, or urban planning. Required credit for the thesis is specified by the department.

GRADUATE FACULTY

Professors: W. G. Carnes (Chairman of Department), W. M. Keith.

Associate Professor: T. C. Hazlett.

Assistant Professors: A. J. Rutledge, D. L. Walker, Jr.

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semipublic, and public properties. 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

447. **Advanced Landscape Construction.** Advanced investigations and applications of new techniques of construction to landscape development. ½ or 1 unit. Prerequisite: Landscape Architecture 243, 244, bachelor's degree in landscape architecture, or consent of instructor.

457. **Advanced Planting Design.** Theory and application of planting design in relation to private, semipublic, and public properties. ½ or 1 unit. Prerequisite: Bachelor's degree in landscape architecture.

477. **Theory and Application of Landscape Design.** Advanced studies in the physical and ecological bases of landscape, aesthetic principles, and landscape planning. ½ or 1 unit. Prerequisite: Landscape Architecture 337 or consent of instructor.

487. **Seminar.** ½ or 1 unit.

499. **Thesis Research.** ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Advanced Landscape Design, I.** Advanced problems of landscape design for urban and institutional situations. 1 to 1½ units. Prerequisite: Landscape Architecture 236.

338. **Advanced Landscape Design, II.** Terminal project; comprehensive landscape architectural development. 1 to 2 units. Prerequisite: Landscape Architecture 337.

LATIN-AMERICAN STUDIES

Graduate minors in Latin-American studies are administered by the Director of the Center for Latin-American Studies.

Candidates for the master's degree who elect a minor in Latin-American studies must complete two units from the courses listed below. Doctoral candidates who elect a minor in this area must complete four units for a sole minor, or two units for a split minor, from the following courses.

These elective courses must be taken in at least two departments and are described under the departmental listings: Agricultural Economics 401; Agronomy 429; Anthropology 350, 352, 361, 380, 490; Art 318, 491; Botany 300; Economics 352, 411, 490; Geography 332, 495; History 375, 376, 377, 476; Philosophy 319, 483; Political Science 342, 343, 441, 442, 493; Portuguese 301, 303, 304, 305, 306, 405, 406, 491; Sociology 373, 490; Spanish 307, 308, 332, 431, 432, 433, 434, 435, 436, 437, 438.

Students in technical and professional colleges and schools of the University who seek knowledge of Latin-American affairs, culture, and languages are invited to consult with the Director of the Center for Latin-American Studies, 1207 West Oregon Street, Urbana, or with their advisers, in order to develop programs suited to their individual needs. Such a program may often be adopted as a special minor under existing regulations if the student so desires. These courses are of particular value to students who intend to carry on technical or professional work in the Latin-American area for the government, private business, publications, or religious organizations.

LAW

The College of Law offers a program of graduate work leading to the Master of Laws (LL.M.), Master of Comparative Law (M.C.L.), and Doctor of the Science of Law (J.S.D.).

A student whose undergraduate study in law has been in systems based on the Anglo-American common law is eligible to apply for candidacy for the Master of Laws or Doctor of the Science of Law. A foreign lawyer whose prior law study has been in a system which is not based on the Anglo-American common law may, in exceptional cases, be admitted to candidacy for the Master of Laws or Doctor of the Science of Law, or such foreign lawyer may apply for candidacy for the Master of Comparative Law. The Master of Comparative Law program is designed to develop facility in the comparative method and to prepare a foreign lawyer to deal knowledgeably with Anglo-American problems.

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws unless he has a grade-point average of 3.5 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of Science of Law is normally required to have a grade-point average of 4.0 in all law work previously undertaken, and also to present evidence that he has the ability to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Doctor of Law (or equivalent degree), or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for an advanced degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than

one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the Master of Laws must secure an average of 3.5 in his graduate law courses; the candidate for the Doctor of the Science of Law, an average of 4.0.

Details of the programs may be obtained from the Dean of the College of Law, 209 Law Building.

GRADUATE FACULTY

Professors: J. E. Cribbet (Dean of College of Law), F. K. Beutel, C. H. Bowman, K. S. Carlston, R. G. Cohn, W. H. Davis, G. T. Frampton, P. H. Hay, W. R. LaFave, J. O'Connell, S. J. Plager, E. F. Scoles, V. J. Stone, J. N. Young.

Associate Professors: D. C. Baum, R. W. Findley, S. B. Goldberg, H. D. Krause, R. Reisner, H. Semmel.

Assistant Professor: P. B. Maggs.

COURSES FOR GRADUATES

400. **Seminar: Legal Education.** Problems in legal education, curricula, teaching materials, methods of teaching, the place and function of individual courses in the law school program. ½ unit.

499. **Thesis Research.** ½ to 3 units.

PROFESSIONAL COURSES

301. **Contracts A.** Offer and acceptance, consideration, seals, Statute of Frauds. 1 unit (for recommended M.C.L. candidates only). Davis, Hay, Maggs.

302. **Contracts B.** Third-party beneficiaries, assignment, conditions, impossibility, anticipatory repudiation, and discharge; contract and quasi-contract distinguished, and measure of damages for each. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 301. Benfield, Davis, Hay, Maggs.

303. **Torts A.** Basic course in civil wrongs, including intentional infliction of emotional harm, right of privacy, libel and slander, and unfair commercial practices. ½ unit (for recommended M.C.L. candidates only). Krause, O'Connell.

304. **Torts B.** Basic course in civil wrongs, including negligence, liability without fault, tort liability of owners and occupiers of land, and the impact of insurance on tort liability. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 303. Krause, O'Connell.

305. **Judicial Remedies.** Introduction to civil procedure, common-law forms of action, extraordinary legal remedies, nature of equity jurisprudence, equitable remedies, abolition of the forms of action, fusion of law and equity, statutory remedies. 1 unit (for recommended M.C.L. candidates only). Semmel, Stone.

307. **Property A.** The concept of property; acquisition of private property; recognized property interests (personal, real, estates in land). 1 unit (for recommended M.C.L. candidates only). Cribbet, Findley, Plager.

308. **Property B.** Gratuitous transfer of property interests; commercial transfers (sale, lease); the use of property. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 307. Cribbet, Findley, Plager.

309. **Criminal Law.** The sources and purposes of the criminal law; the meaning of criminal responsibility; the characteristics of particular crimes. 1 unit (for recommended M.C.L. candidates only). Bowman, LaFave.

310. **Constitutional Law.** The apportionment of governmental power between the United States and the states, and the limitations on power resulting from the contract, equal protection, and due process clauses. 1 unit (for recommended M.C.L. candidates only). DAVIS, GOLDBERG, LAFAVE, REISNER.

320. **Business Associations.** The fundamental legal consequences to principals, agents, and third parties of association in various types of business transactions and in various forms of business enterprise. 1 unit (for recommended M.C.L. candidates only). BAUM, FRAMPTON.

322. **Commercial Law, I.** A study of the major problems involved in the exchange of goods and commercial paper with special emphasis upon the history and interpretation of the Uniform Commercial Code as it affects commercial transactions. 1 unit. BENFIELD, BEUTEL.

323. **Administrative Law.** The functions of administrative tribunals in federal, state, and municipal government, the procedure before such administrative tribunals, and judicial relief from administrative decisions. 1 unit. COHN.

324. **Corporations.** Promotion and organization of corporations and the rights and liabilities of officers, directors, and shareholders. 1 unit. BAUM, FRAMPTON.

325. **Pleading.** Obtaining information and forming issues in advance of trial. 1 unit. SEMMEL.

326. **Evidence.** Principles governing the competency of witnesses and the admissibility of evidence. 1 unit.

328. **Income Taxation.** A study of federal income tax problems relating to business and investment transactions. Subjects treated include the concept of taxable income; allowable deductions; accounting for income and deductions; capital gains; partnership operations; corporate distributions and reorganizations; and tax procedure. 1 unit. MCCORD, YOUNG.

329. **Decedents' Estates and Trusts.** A study of the gratuitous disposition of property by intestacy, by will, and by inter vivos gifts and trusts, including administration of decedents' estates and trusts. 1 unit. PLAGER, SCOLES.

330. **Restitution.** Contractual and quasi-contractual remedies (both legal and equitable) available because of duress, fraud, innocent misrepresentation, mistake, illegality, and economic compulsion in the formation and discharge of contracts and other transactions. 1 unit. DAVIS.

331. **Legislation.** A study of legislative policies and procedures, of legislation as a source of law, of types of statutes and their structure, and of the problems of interpretation. 1 unit. COHN.

333. **Persons.** Creation and dissolution of the family unit and relations between members thereof; marriage, separation, divorce, rights and duties of spouses and means for their enforcement; legal capacity of wife and infant. ½ unit. CARLSTON.

334. **Criminal Law Administration and Procedure.** Problems in the administration of the criminal law; a study of criminal procedure from arrest to the end of the prosecution in a court of review, with emphasis on procedure as a device for social regulation, and including an appraisal of aims and workings of probation, parole, and executive clemency. ½ unit. BOWMAN, LAFAVE.

335. **Trials and Appeals.** Litigation from process through appeal, excluding pleading and evidence. 1 unit. STONE.

337. **Commercial Law, II.** Selected problems under the Uniform Commercial Code in modern commercial banking law and practice. ½ unit. BENFIELD.

338. **Insurance.** Personal and property insurance; formation of the insurance relation; concealment, warranties, representations; insurable interests; conditions; subro-

gation; waiver and estoppel; incontestability; the respective interests of the beneficiary, insured, insurer, assignee, and creditor, and facts constituting maturity in life, accident, fire, theft, liability, and collision policies. ½ unit. DAVIS.

339. **Conflict of Laws.** Problems from conflict of laws involving jurisdiction of courts; judgments; torts and workmen's compensation; contracts; property; family law; administration of estates; business organizations; governmental activities. 1 unit. HAY, SCOLES.

340. **Local Government Law.** History and functions; judicial, legislative, and administrative control; creation, dissolution, and changes in structure; law-making powers; finance; planning and development functions; regulatory powers; contracts; tort liabilities; federal-local and inter-local relations. 1 unit. BAUM.

341. **Oil and Gas.** Nature of the property interests in oil and gas; legal interests created by oil and gas leases; validity of leases; the habendum clause; the drilling and rental clauses; transfer of oil and gas interests; rents and royalties; public regulation of the production of oil and gas. 1 unit.

342. **Mortgages.** A study of real estate mortgages. 1 unit. FINDLEY.

343. **Admiralty.** Admiralty and maritime jurisdiction; the maritime lien; carriage of goods; salvage; general average; collision; claims of seamen; limitation of liability; application of state law; sovereign responsibility; choice of law. 1 unit. DAVIS.

344. **Creditors' Rights.** Remedies of the delinquent debtor and his creditors under the Bankruptcy Act; liquidation and rehabilitation; exercises in bankruptcy procedures. 1 unit. BOWMAN.

345. **Civil and Political Rights.** A study of some of the basic problems in the relation of the individual to government and in the protection of rights of minority groups. ½ unit. REISNER.

346. **Future Interests.** A study of the validity and effect of gratuitous dispositions of assets in which enjoyment is postponed, restrained, or long continued; classification of future interests; construction; powers of appointment; rule against perpetuities and related restrictions. 1 unit. SCOLES.

347. **Labor Law, I.** Same as Labor and Industrial Relations 347. The law of industrial relations with special emphasis on recent cases and legislation; the establishment of the collective bargaining relationship; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit. GOLDBERG.

348. **International Law.** The nature, sources, and subjects of international law, its place in the control of international society, and an examination of the law of jurisdiction, territory, recognition, and succession of states, rights and immunities of states in foreign courts, diplomatic immunities, treaties, protection of citizens abroad, settlement of international disputes, war and neutrality, the United Nations, and the International Court of Justice. 1 unit. CARLSTON.

349. **State and Local Taxation.** Proper and improper purposes of taxation; the general property tax and its administration; taxpayers' remedies; excise taxes on business concerns and transactions; problems of jurisdiction to tax. ½ unit. YOUNG.

351. **Jurisprudence.** The place of law in society, the goals and methods of law, the nature of law, relation of law and social science. 1 unit. BEUTEL, CARLSTON.

352. **Taxation of Gratuitous Transfers.** Various tax problems encountered in the distribution of wealth by inter vivos and testamentary disposition, including a study of federal estate and gift taxes, the Illinois inheritance tax, problems in the assignment of income, and federal income taxes upon estates and trusts. Attention is given to tax planning in the distribution of wealth. ½ unit. MCCORD, YOUNG.

353. **Corporation Finance and Securities.** Drafting provisions of preferred shares; counseling problems requiring written memoranda on the application of state and federal securities laws to the marketing of securities and on the effect of statutes and decisions on distribution of dividends, redemption and purchase of shares, and recapitalization, reorganization, and dissolution of corporations. ½ unit. FRAMPTON, MCCORD.

355. **Trade Regulation.** Antitrust law, control of restrictive business practices, monopoly, unfair competition, trademarks, price discrimination, resale price maintenance, Federal Trade Commission. 1 unit. BAUM, CARLSTON.

356. **Federal Courts.** The federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state tribunals. 1 unit. STONE.

358. **Modern Social Legislation.** A focus, for illustrative purposes, on the traffic victim and his claim for compensation: the present common-law method compared with various schemes of social insurance; problems of coordinating, as well as comparing, any such scheme of social legislation with the tort system and with other social and private insurance arrangements such as workmen's compensation, Blue Cross, etc. Attention is given to both broad questions of social policy and technical drafting problems. 1 unit. O'CONNELL.

359. **Legal History.** The development of the common-law system in England and America: the origin and growth of English legal thought, legal doctrine, and legal institutions; the history of real property, contracts, and torts; the origin and development of courts, legislation, equity, the doctrine of precedent; the evolution of the legal profession; the reception of the common law in America. 1 unit.

365. **Tax Problems.** Selected problems relating to partners and partnerships, corporations and shareholders. ½ unit.

369. **Soviet Law.** An examination of Soviet conceptions of the role of law as evidenced both in theory and in practice; emphasis on highlights of Soviet law, with comparison to the common-law and civil-law traditions; study of Soviet court and legislative materials to determine characteristic pattern with respect to: constitution and administration, the relation of the individual with the state and with society; legal regulation of property and productive institutions, private relationships, and international law. 1 unit. MAGGS.

370. **Labor Law, II.** Advanced problems in the law of industrial relations with particular emphasis on the negotiation and administration of the collective bargaining agreement; the relation between the individual and the union. ½ unit. Prerequisite: Law 347 or consent of instructor.

371. **Seminar in Selected Legal Problems.** An introduction to the methods and materials of legal research. The work of the course consists of the discussion of selected topics. In addition, each student investigates a topic approved by the instructor. The results of the investigation are presented orally to the class and submitted in writing to the instructor. The several sections are oriented to different subject matter areas. Credit may be earned in more than one section. ½ unit.

372. **Problems in Estate Planning.** Selected problems in the planning of estates which serve to integrate the basic materials in property, trusts, wills, income, estate, and gift taxation. ½ unit.

382. **Comparative Law.** A comparative analysis of the three basic institutions of private law: tort, contract, and property. The solutions arrived at in the common-law system are contrasted with the solutions arrived at in the civil-law system and in the Soviet legal system. 1 unit. KRAUSE.

383. **Law and Society.** An examination of some important ideas concerning the nature of law and the role of law in society. 1 unit. REISNER.

387. **International Economic Organizations.** A survey of the principal international economic organizations such as GATT, OECD, ECE, and international monetary and investment institutions (IMF, IBRD, AID); an intensive study of the European Common Market, particularly of its laws relating to trade barriers, establishment of companies, and antitrust; United States legislation in the field of international trade (Trade Expansion Act of 1962). 1 unit. HAY.

399. **Research in Special Topics.** Individual research on a special problem selected in consultation with the instructor. ½ or 1 unit.

LIBRARY SCIENCE

The purpose of the Graduate School of Library Science is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree, certificate of advanced study in librarianship, and the doctor's degree in library science.

Master of Science. Applicants for admission to the Graduate School of Library Science must first be admitted to the Graduate College.

In addition to the Graduate College requirements, applicants to the Graduate School of Library Science must meet the following requirements: (1) a minimum grade-point average of 3.75 for the last sixty hours of academic work completed; (2) one sequence (two terms) of courses at the college level in each of the three main fields of science, social science, and humanities, and a total of four such sequences in all; (3) a major subject in any field of study, comparable to the undergraduate major at the University of Illinois (at least twenty-four semester hours); (4) two years of college-level study of any foreign language. This may be either two years of study of one language or one year of each of two languages.

A candidate for the master's degree must complete a prescribed program of undergraduate courses. This requirement may be met by one of the following: (1) completion of a minimum of sixteen semester hours of library science with a grade-point average of at least 4.0 in an institution approved by the Graduate School of Library Science; (2) completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, in the Graduate School of Library Science with a grade-point average of at least 4.0. Exemption from one or more of these courses may be secured by a satisfactory score on a comprehensive examination which is offered on the day preceding the opening of registration each semester and summer session. There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence before taking regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

At least two semesters in residence—or the equivalent—are required to earn the master's degree, in addition to attendance in preparatory courses. In this period, eight units of graduate study should be completed. Each student's program of study, adapted to his particular needs and purposes, is planned in consultation with an adviser at the time of original registration and thereafter. Students who have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to take the comprehensive examination and to complete Library Science 405, 407, and 411 or 412, and one of the 300-level literature courses. No thesis is required.

Students interested in the Advanced Master's program, the Certificate of Advanced Study in Librarianship, and the Doctor of Philosophy degree should write to the Director of the Graduate School of Library Science, 329 Library.

GRADUATE FACULTY

Professors: R. B. Downs (Dean of Library Administration), H. Goldhor (Director of Graduate School of Library Science), G. G. Garrison, H. Goldstein, Frances B. Jenkins, R. F. Stevens.

Associate Professors: Winifred C. Ladley, M. Alice Lohrer.

Assistant Professors: Kathryn L. Henderson, Cora E. Thomassen.

Instructor: D. E. Carroll.

COURSES FOR GRADUATES

402. **Studies in Reading.** Designed to acquaint students with the major areas of investigation and interest in reading. Special attention is given to studies of reading interests and habits of children, youth, and adults. Class discussions are devoted to analysis of various studies and their implications for library service and classroom teaching. 1 unit. Ladley, Lohrer.

405. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. 1 unit. Field.

406. **Library Service to Children and Young Adults.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young adults in the public library. 1 unit. Credit is not given for Library Science 406 in addition to credit in Library Science 307. Prerequisite: Library Science 204 or 405. Ladley, Lohrer.

407. **Cataloging and Classification, I.** The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and Library of Congress subject headings. 1 unit. Henderson.

408. **Cataloging and Classification, II.** The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the adminsitrative problems of a cataloging department. 1 unit. Prerequisite: Library Science 407. Henderson.

409. **Communication Roles and Responsibilities of Libraries.** Mass media of communication are considered in terms of their relations with modern library services; media organization, content, and research are reviewed; problems of intellectual freedom are considered as an aspect of communications behavior; and the potential role of electronic devices in library activities now and for the future is discussed. 1 unit. Goldstein.

410. **Adult Education and Libraries.** The literature, history, and problems of adult education in the United States are presented in relation to the role of the library as an educational agency. Students study organization for adult education in the community and become familiar with the significant methods and materials used in a variety of educational programs. 1 unit. Goldstein.

411. **Reference Service in the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in various subject fields, with training and practice in their use for solving questions arising in reference service. 1 unit. Stevens.

412. **Science Reference Service.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. 1 unit. JENKINS.

424. **Government Publications.** The nature and scope of American and British government publications; the problems of organization arising from their form and from the methods of their production and distribution. 1 unit. Prerequisite: Library Science 411 or 412, or consent of instructor. FIELD.

427. **Resources of American Research Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; spatial and financial aspects of library resources; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; and ways and means of developing research collections in special subject fields. 1 unit. STEVENS.

428. **Library Buildings.** A study of the library's physical plant in the light of changing concepts and patterns of library service. Present-day library buildings, both new and remodeled, are analyzed and compared with each other as well as with buildings of the past. The interrelationship of staff, collections, users, and physical plant is examined in detail. Class discussion is supplemented by visits to new libraries and conferences with their staffs. 1 unit. Prerequisite: Library Science 405 or consent of instructor. GARRISON.

429. **Information Storage and Retrieval.** Analyzes the problems which confront libraries and library users as a result of the growth of literature; reviews the various systems for storing and retrieving information; introduces the underlying models and basic types of equipment for both traditional and non-conventional systems; emphasizes practical applications in libraries. 1 unit. Prerequisite: Library Science 405; consent of instructor. CARROLL.

430. **Advanced Reference.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. 1 unit. Prerequisite: Library Science 424 or consent of instructor. CARROLL.

431. **Books and Libraries in the Ancient and Medieval World.** The development of writing and of the book in ancient and medieval times; book collecting and the growth of libraries from earliest times to the discovery of printing. 1 unit. STEVENS.

432. **Books and Libraries Since the Renaissance.** Same as Communications 432. The development of printing since the fifteenth century, and its effect on the nature and use of the book; the growth of national, college and university, public, and other libraries in Europe and America from the Renaissance to the present day. 1 unit. STEVENS.

433. **Advanced Subject Bibliography.** A study of the literature, information sources, and reference aids in various specialized fields of knowledge, identified as different sections of this course, from the point of view of their use by librarians. No student may take more than two different sections for credit toward a degree: (a) biological sciences, (b) chemistry, (c) education and psychology, (d) engineering, (e) law, (f) maps, (g) music, (h) mathematics, (i) Slavic bibliography. ½ unit. Prerequisite: Consent of instructor. STAFF.

434. **Library Systems.** Considers the development of library systems, with special reference to public libraries as a norm for the development of library services: library standards, the growth and development of county and regional libraries, the role of the state library and of federal legislation are among the topics treated in detail. 1 unit. Prerequisite: Library Science 405 or consent of instructor. GOLDSTEIN.

436. **Development of the Library Catalog.** The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor. FIELD.

438. **Administration and Use of Archival Materials.** Administration of archives and historical manuscripts, with emphasis on the processing and research use of archival materials. 1 unit. Prerequisite: Consent of instructor. BRICHFORD.

439. **Medical Literature and Reference Work.** Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources. (only at the University of Illinois Medical Center in Chicago); S; 1 unit. Prerequisite: Consent of instructor.

441. **History of Children's Literature.** Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. 1 unit. LOHRER.

443. **Contemporary Book Publishing.** Survey of twentieth-century book publishing, particularly in America, placing it in an economic, social, and literary context. Emphasis is on production, technological developments, economic structure, methods of distribution and promotion, and book publishing as an art. 1 unit. BLUM.

COURSES FOR ADVANCED GRADUATES

450. **Advanced Studies in Librarianship.** Directed and supervised investigation of selected problems in library resources, reference service, research libraries, reading. public libraries, or school libraries. ½ to 2 units. Prerequisite: Fifth-year degree in library science or consent of director. STAFF.

462. **History of Education for Librarianship.** A study of the origin and development of library science education in this country and abroad; emphasis is placed on the major events and activities which led to the present status of library school programs. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. GOLDSTEIN.

463. **Current Developments in Technical Services.** An examination of changing policies and procedures in the administration of acquisitions, cataloging, binding, photographic reproduction, and related areas. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STEVENS.

465. **Librarianship and Society.** Analysis of the role and functions of libraries in the twentieth century; the changing characteristics of information and knowledge are viewed as major determinants of libraries' relations to society. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor.

468. **Teaching Methods and Special Problems in Contemporary Library Schools.** Designed for those interested in preparing for the teaching of library science at the graduate level. Current library school programs and the various methods of instruction are analyzed as to effectiveness and application for the major areas of library science content; attention is given to the process of curriculum construction to meet the changing needs of the profession and to the experience of other professions. 1 unit. Prerequisite: Library Science 462 or consent of instructor. GOLDSTEIN.

469. **Principles of Research Methods.** Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. 1 unit. Prerequisite:

Knowledge of the principles of statistics, Master of Science in Library Science, or consent of instructor. GOLDHOR.

499. **Thesis Research.** Individual study and research. Section A: M.S. candidates, 0 to 2 units. Section B: Ph.D. candidates, 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Literature of the Humanities and Social Sciences.** This course is designed to build a knowledge of the scope and significant characteristics of the several fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. 1 unit. CARROLL.

302. **Literature of the Sciences.** An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. 1 unit. Prerequisite: Library Science 204, 258, or consent of instructor. JENKINS.

303. **Library Materials for Children.** The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, social, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. Credit is not given for Library Science 303 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY, LOHRER, THOMASSEN.

304. **Library Materials for Young Adults.** The selection and use of library materials for the young adult in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. Credit is not given for Library Science 304 in addition to credit in Library Science 307. ½ or 1 unit. LOHRER, THOMASSEN.

307. **Library Materials and Services for Children and Young Adults.** A nonspecialist's view of the materials and services involved in work with children and young adults, including a brief survey of print and nonprint materials for children and young people, and basic guidelines for library services to them. Credit is not given for Library Science 307 in addition to credit in Library Science 303, 304, 309, or 406. 1 unit. Prerequisite: Consent of instructor.

308. **Audio-Visual Services in Libraries.** Designed to acquaint students with the typical audio-visual programs and responsibilities of libraries. Group activities stress, through presentation and evaluation, the use of materials and related equipment necessary for film, radio and television, exhibit and other programs of libraries. The practices of audio-visual departments in libraries are reviewed and evaluated. 1 unit. BEEBE.

309. **Storytelling.** Fundamental principles of the art of storytelling including techniques of adaptation and presentation for children of various ages. Content and sources of materials; story cycles; methods of learning; practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and for television. Open to undergraduates and non-Graduate School of Library Science students. Credit is not given for Library Science 309 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY.

LIFE SCIENCES

(Including Biology, Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology)

The School of Life Sciences is a unit of the College of Liberal Arts and Sciences and includes the Departments of Botany, Entomology, Microbiology, Physiology and Biosphysics, and Zoology. Study programs leading to the graduate degrees of Master of Science and Doctor of Philosophy exist in each of the departments and are described in detail in the following pages. Interdepartmental study programs leading to advanced degrees in cell biology and virology, and developmental biology, are administered within the School. The School also participates with other departments of the University in offering the Ph.D. program in genetics (see page 186) and with the Department of Chemistry and Chemical Engineering in offering a program in biophysical chemistry (see page 97). Applicants who desire to enter any of the graduate study programs are usually required to have earned a grade-point average of at least 4.0 for their last sixty hours of undergraduate work. In certain programs, applicants with a grade-point average between 3.5 and 4.0 are considered by a special committee.

Support for graduate training is available in the form of teaching or research assistantships, University fellowships, or trainee fellowships. Prospective students may obtain application forms and relevant information for departmental study programs from the executive officer of the appropriate department, or for interdepartmental study programs from the Director of the School of Life Sciences.

INTERDEPARTMENTAL STUDY PROGRAMS

Master of Science in the Teaching of the Biological Sciences and General Science. This degree is offered with the completion of the fifth year in the teacher-education curriculum in biological and general science. The degree is primarily intended for but not restricted to certified teachers of biology and general science in junior high school, high school, and junior college. For admission to this degree program, students must have a grade-point average of at least 3.5. See pages 41 and 42.

Candidates for the Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. Electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry is strongly advised. The adviser for candidates for this degree is Professor Joseph Larsen, 318c Morrill Hall.

Master of Science in Biology. A program of study leading to the master's degree in biology is designed for individuals who (1) wish additional training at the master's level for professional proficiency in teaching or research, (2) desire to continue to the Ph.D. degree, possibly in one of the programs sponsored by the School of Life Sciences, or (3) do not wish to limit their training to a single area of biology.

Applications from individuals with grade-point averages between 3.5 and 4.0 must be accompanied by a three-hundred word essay by the applicant outlining his educational objectives.

Although no specific undergraduate courses are required for admission to this curriculum, a year of physics and a course in organic chemistry must be completed before a degree is granted.

Candidates for the degree are advised to obtain a broad, basic training in biology and are examined in aspects of cellular, organismic, and population biology. Of the eight units required for the degree, at least one unit must be taken in 400-level courses. A thesis is not required, but at least one course must be included in which individual problems are assigned. A comprehensive examination is required of all candidates for the degree.

Students who are preparing themselves for high school teaching and who are not yet certified must fulfill state certification requirements.

Doctor of Philosophy in Biology. The School of Life Sciences offers Ph.D. programs in two specified interdepartmental areas, cell biology and virology, and developmental biology. Entrance requirements, in addition to those listed on page 232 for the M.S. program, include background training in general biology, physics, biochemistry, and calculus, but deficiences in these areas may be remedied during the first year of graduate study. Study programs are designed to suit individual needs in consultation with advisers. Descriptions of the area programs are given below.

Students who have been accepted for one of these programs may select any faculty member in the School of Life Sciences, or an appropriate member of the Biochemistry Division as a major adviser. Additional information may be obtained from the Director of the School of Life Sciences.

CELL BIOLOGY AND VIROLOGY

The cell biology and virology program emphasizes molecular mechanisms and is therefore addressed to students who have acquired or wish to acquire a strong background in chemistry. Areas of research open to students in this program include cytochemistry, biochemistry of subcellular systems, cellular differentiation, interacellular regulation of meiosis and mitosis, circadian rhythms, cellular genetics, and virology.

DEVELOPMENTAL BIOLOGY

The developmental biology program emphasizes the study of developmental processes in cells, tissues, and organ systems. Training in the techniques of cytochemistry, histochemistry, cell fractionation, electron microscopy, microspectrophotometry, microelectrophoresis, immunology, tissue culture, and transplantation of tissues and organs are provided as required.

In addition to the entrance requirements, students are required to complete courses in embryology, cytology-histology, and genetics.

Biology

The following courses are administered directly by the School of Life Sciences. These courses, as is the case with departmental courses, are applicable to the study programs within the School.

COURSES FOR GRADUATES

409. History of Biology. The development of biological concepts from the classical Greek period to the present. 1 unit. Prerequisite: Consent of instructor.

423. Electron Microscopy. Same as Chemistry and Zoology 423. Lectures, discussions, and demonstrations on electron optics, design and operation of electron microscopes; sectioning, replication, and shadow casting of specimens; applications in various sciences. Open to qualified graduate students in any department. ¼ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; consent of instructor. HALL.

429. Electron Microscopy Laboratory. Same as Chemistry and Zoology 429. Essentially individual instruction. Detailed training in operation and care of electron microscopes (four types); preparation of specimens including microtomy, electron staining, replication, and shadow casting; measurements and interpretations; special projects related to student's research interests. Open to qualified graduate students in any department. ½ or ¾ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; credit or registration in Biology 423; consent of instructor. HALL, PAGE.

490. Special Topics in Biology. Individual topics in research and/or reading conducted under the supervision of faculty members in the School of Life Sciences. This

course is particularly designed for students enrolled in the biology program who would like to become more familiar with specialized fields of study prior to committing themselves to a specific area for their doctorate degree. 0 to 1 unit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. **Population Biology.** A study of problems associated with the behavior of plant and animal populations based on genetic, evolutionary, and ecological principles. ¾ unit. Prerequisite: Biology 151 and 251, and/or consent of instructor. GHENT.

371. **Quantitative Biology.** Theory and practical application in biology of probability and statistics. Lectures and assigned problems. ¾ unit. Prerequisite: College algebra; consent of instructor.

DEPARTMENTAL STUDY PROGRAMS AND COURSES

Botany

The Department of Botany offers graduate work leading to the Master of Science and Doctor of Philosophy. Candidates for advanced degrees must have had at least twenty hours of undergraduate work in botany, or fifteen hours in botany and five hours in a related subject acceptable to the department. The applicant's grade-point average must be at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The following subjects comprise a partial listing of the areas of specialization available in the department: cytology, cytogenetics, anatomy, morphology, morphogenesis, paleobotany, ecology, plant geography, taxonomy, cytotaxonomy, physiology (including photosynthesis), physiological genetics, mycology, phycology, virology, and ultrastructure.

Courses offered in the departments of Agronomy, Chemistry and Chemical Engineering, Entomology, Geography, Geology, Horticulture, Mathematics, Microbiology, Physics, Physiology and Biophysics, Plant Pathology, and Zoology are available to advanced students and offer a broad foundation for botanical work. Graduate students in botany may elect their minor subjects in one or two of these fields.

Special Facilities. Graduate students may avail themselves of the University herbarium which contains 500,000 specimens of vascular plants, bryophtyes, algae, fungi, and fossil plants. As field laboratories, the University maintains two tracts of woodland, Brownfield Woods and Trelease Woods; in addition, certain areas of Robert Allerton Park near Monticello have been designated for research and study. Greenhouses, garden plots, and growth chambers are maintained for experimental work with living plants. Well equipped laboratories are available for each area of specialization within the department. The Maize Genetics Research Laboratory maintains an extensive collection of maize genetic stocks adapted to the North Central states; the College of Agriculture and the Agricultural Experiment Station offer exceptional facilities to graduate students in plant genetics, plant pathology, and in some of the other plant sciences. The Biology Library, with over 70,000 volumes, offers excellent library facilities, with bibliographical aids including the Gray Herbarium Card Index of American Plants, the Index of American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis.

Departmental Qualifying Examination. A written qualifying examination must be taken by all new graduate students majoring in botany at the beginning of their first semester. This examination is offered in the week prior to the opening of the first or fall semester and in the week prior to the opening of the second or spring semester. The examination is used to determine the level of information in the following areas:

(1) ecology, (2) genetics, (3) morphology, (4) physiology, and (5) taxonomy. The results of the examination are used by the departmental qualifying examination committee and the student's adviser to recommend future graduate courses, and no permanent record is made of the results.

Students with deficient preparation in any one of the five areas can remove the deficiency: (1) by passing an examination in the deficient areas or substitute areas after a period of independent reading and study; (2) by registration in a course in the field of deficiency and by passing the course with a grade of B or better; (3) by substitution of courses in botany, approved by the qualifying examination committee and the adviser. A limit of two substitutions is allowed for each student.

Master of Science. During their graduate or advanced undergraduate work, candidates for this degree must have completed courses in the following basic fields of botany: (1) taxonomy (Botany 460 or equivalent), (2) morphology (Botany 302 and 303, or equivalent), (3) ecology or plant geography (Botany 381 or equivalent), (4) genetics (Botany 210 or equivalent), (5) physiology (Botany 330 or equivalent).

A thesis is not required of candidates for the Master of Science except at the option of the graduate student's major adviser. Graduate students do not receive credit toward the master's degree in Botany 499 unless they write acceptable master's theses. A student may engage in graduate work toward the Doctor of Philosophy without having obtained a master's degree.

Doctor of Philosophy. Candidates for this degree must complete the course requirements listed above before receiving the Doctor of Philosophy. Having satisfied these basic course requirements imposed by the qualifying examination, the candidate for the doctor's degree may elect whatever other graduate courses he desires, subject to the approval of this major adviser and to the general regulations of the Graduate College concerning requirements in his major and minor fields (see pages 42 to 45).

GRADUATE FACULTY

Professors: L. M. Black, L. C. Bliss, H. J. Fuller, J. B. Hanson, G. N. Jones, J. R. Laughnan, E. I. Rabinowitch, M. E. Reichmann, D. P. Rogers, D. M. Steffensen.

Associate Professors: Z. B. Carothers, Govindjee, J. F. Nance, D. J. Paolillo, T. L. Phillips.

Assistant Professors: L. R. Hoffman, R. MacLeod, W. W. Payne.

COURSES FOR GRADUATES

402. Molecular Genetics. See Zoology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

403. Physiology of Fungi. Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Organic chemsitry or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

405. Microbiological Genetics. See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

410. Botany Discussions. All graduate students in botany, except those with conflicting teaching assignments, are required to register in and attend the general seminar. No credit is given except to those students presenting the results of their Ph.D. thesis research. 0 or ¼ unit. Staff.

411. **Discussions in Genetics and Cytogenetics.** Same as Microbiology and Zoology 411. ¼ unit. BADER, BROWN, DRAKE, KITZMILLER, LAUGHNAN, NANNEY, STEFFENSEN.

413. **Discussions in Plant Physiology.** ¼ unit. NANCE.

414. **Discussions in Plant Morphology and Taxonomy.** ¼ unit. STAFF.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. ¼ unit. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. BLISS.

419. **Discussions in Photosynthesis and Related Topics.** ¼ unit. Prerequisite: Consent of instructor. GOVINDJEE, RABINOWITCH.

421. **Cytogenetics.** Same as Zoology 421. Chromosome theory: the structure, behavior, and physiology of chromosomes in heredity and development. 1 unit. Prerequisite: Botany 210, or Microbiology 330, or consent of instructor. STEFFENSEN.

424. **Mineral Nutrition of Plants.** Same as Agronomy and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN

427. **Discussions in Mycology.** A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. ¼ unit. Prerequisite: Consent of instructor. ROGERS.

433. **Advanced Physiology of Growth, Responses, and Reproduction.** 1 unit. Prerequisite: Botany 330 or equivalent. HANSON, MCCOLLUM, NANCE, WILSON.

436. **Principles in Plant Physiology.** A laboratory course illustrated by experiments with algae and including experiments on the nutrition of algae, photosynthesis, respiration, and enzyme processes; special emphasis is on photosynthesis. Enrollment limited to six students. 1 unit. Prerequisite: At least one course at the college level in each of the following: biology, chemistry, and physics (or physical chemmistry). GOVINDJEE.

450. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. HOFFMAN.

460. **Advanced Taxonomy of Flowering Plants, I.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Botany 160 or one year of botany or another biological science, or consent of instructor. JONES.

461. **Advanced Taxonomy of Flowering Plants, II.** The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Botany 160 and 210, or equivalent; consent of instructor. PAYNE.

471. **Advanced Mycology: Special Groups.** The several classes of fungi and their activities are considered in successive semesters. Special groups within these classes may be selected for concentrated study, depending upon the student's interest in mycology. ½ unit. Prerequisite: Botany 372 or consent of instructor. ROGERS.

493. **Advanced Studies in Botany.** ½ to 2 units. Not more than one unit may be applied toward the Graduate College master's degree requirement of three units of course work at the 400 level. Work may be taken in the following fields:

(a) **Anatomy.** Carothers, Paolillo.
(b) **Bryology.** Jones.
(c) **Cytogenetics.** Steffensen.
(d) **Cytology.** Steffensen.
(e) **Ecology.** Bliss.
(f) **Genetics.** Laughnan.
(g) **Morphogenesis.** Paolillo.
(h) **Morphology.** Carothers, Phillips.
(i) **Mycology.** Rogers.
(j) **Paleobotany.** Phillips.
(k) **Photosynthesis.** Govindjee, Rabinowitch.
(l) **Phycology.** Hoffman.
(m) **Physiology.** Boyer, Hanson, Nance.
(n) **Taxonomy.** Jones, Payne.
(o) **Ultrastructure.** Carothers, Hoffman, Paolillo.
(p) **Virology.** Black, MacLeod, Reichmann.

499. **Thesis Research.** Individual work under supervision of member of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. Staff.

302. **Comparative Morphology: Nonvascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, and bryophytes. Students receiving credit for Botany 302 do not receive credit for Botany 304. ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. Hoffman, Phillips, Rogers.

303. **Comparative Morphology: Vascular Plants.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative vascular plants, including psilopsids, lycopsids, sphenopsids, ferns, gymnosperms, and angiosperms. Students receiving credit for Botany 303 do not receive credit for Botany 304. ½ unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, or equivalent. Phillips.

304. **General Plant Morphology.** A survey of the principles of plant morphology as exemplified by the various plant groups. Modification of course is made to meet the needs of teachers and prospective teachers. Students receiving credit for Botany 304 do not receive credit for Botany 302 or 303. S; 1 unit. Prerequisite: Botany 100, Biology 110 and 111, or Division of General Studies 131 and 132, or equivalent; consent of instructor. Staff.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. This course adjusted to professional semester (practice teaching) for students in teacher-training curriculum. Two four-hour field trips to be given on Saturdays. ½ unit. Prerequisite: Botany 100 and Zoology 104, or a one-year course in general biology; expectation of teaching. Staff.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; organic chemsitry; or consent of instructor. MacLeod.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. Alger, Silverman.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. Phillips.

330. **Intermediate Plant Physiology.** A lecture and laboratory course dealing with the principles of plant physiology at an intermediate level. For students majoring in botany and others primarily interested in the plant sciences. 1 unit. Prerequisite: One year of biology; one semester of organic chemistry. Nance.

331. **Experimental Cytology.** Same as Zoology 331. Organization of cells of higher organisms with emphasis on the relationships between structure and function. The laboratory stresses modern cellular techniques. 1 unit. Prerequisite: Botany 100 or Zoology 210 or Biology 151 and 251; consent of instructor; biochemistry is recommended. Davenport, Steffensen.

340. **Histological Technique.** Survey of techniques used in the preparation of plant tissues for microscopical examination. 1 unit. Prerequisite: One year of botany or ten hours of zoology; consent of instructor. Paolillo.

341. **Field Ecology.** Study of plant communities in various sections of North America during spring vacation (trips rotate on a three-to-five-year basis); outdoor cooking and camping; transportation in University cars. ¼ unit; may be repeated for a maximum of ¾ unit. Prerequisite: One of the following—Botany 160, 366, 381, 385; consent of instructor. Bazzaz, Bliss.

345. **Plant Anatomy.** Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. 1 unit. Prerequsiite: One year of botany. Carothers.

366. **Field Botany.** Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. Staff.

372. **General Mycology.** Structure, classification, and identification of fungi, including those of economic importance. 1 unit. Prerequisite: One year of botany, entomology, microbiology, or zoology. Rogers.

381. **Plant Ecology.** Principles of ecology, exemplified by vegetation and environments of Illinois. 1 unit. Prerequisite: Botany 160 or equivalent. Bliss, Boyer.

382. **Ecological Methods.** Field methods used in plant ecology. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: One year of botany including Botany 381 or equivalent. Bliss, Boyer.

385. **Plant Geography of North America.** Vegetation regions and principal subdivisions; enviornments plant cover, floras. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Botany 381 or equivalent; one course in geology is recommended. Bliss.

Entomology

The Department of Entomology offers graduate work leading to the Master of Science and Doctor of Philosophy. Admission requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology gain a thorough grounding in the fundamentals of physical and biological science, mathematics, and the liberal arts.

Candidates for the Master of Science in Entomology are required to earn two units in a basic sequence that includes the fundamentals of insect morphology, physiology, and taxonomy, plus one unit each in more advanced courses in insect morphology, physiology, and control. Electives make up the balance of the eight-unit requirement. Not more than two units of research credit may be elected, and if research credit is presented, a thesis is required. The candidate must pass an oral examination covering the general field of entomology.

Candidates for the Doctor of Philosophy in Entomology must satisfy the department course requirements for the master's degree and must also earn one unit of credit in insect bionomics and one unit in insect taxonomy. The remainder of their program is made up of electives.

The chief fields of specialization in the department are: general entomology (including morphology and taxonomy), insect bionomics, applied entomology (including economic entomology and medical entomology), toxicology of insecticides, and insect physiology. The department is well equipped to offer work in these areas, and the facilities of the State Natural History Survey are also available for advanced study. Outstanding entomological library facilities are located on the campus.

The requirements of the department in regard to minors are the following: For a sole minor, four units must be taken outside the department in one of the following areas: agronomy, botany (including plant pathology), chemistry, horticulture, microbiology, physiology, and zoology. A first minor (two units) may be taken in a field of specialization in entomology other than the major, and the second minor (two units) must be in a related subject outside the department. For minors outside the Department of Entomology, the candidate should in all cases check the requirements both with his adviser and with the department concerned.

GRADUATE FACULTY

Professors: C. W. Kearns (Head of Department), G. Fraenkel, W. R. Horsfall, H. H. Ross, R. B. Selander, J. G. Sternburg.

Associate Professors: S. Friedman, A. W. Ghent, E. R. Jaycox, J. R. Larsen, G. P. Waldbauer.

Assistant Professor: Judith H. Willis.

COURSES FOR GRADUATES

410. Insect Morphology. A comprehensive study of the internal and external structure of insects from the comparative viewpoint. 1 unit. Prerequisite: Entomology 301. Larsen, Sternburg.

413. Medical and Veterinary Entomology. Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. 1 unit. Prerequisite: Entomology 101, 103, or 301; or Zoology 320. Horsfall.

420. Chemistry and Toxicology of Insecticides. Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. 1 unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. Kearns, Sternburg.

422. Insect Physiology. A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. 1 unit. Prerequisite: Entomology 301; a course in organic chemistry. Friedman, Larsen.

423. Insect Behavior. An analysis of the physiological basis of insect behavior, including a thorough study of the various sensory systems. 1 unit. Prerequisite: Entomology 301. Waldbauer.

424. **Advanced Insect Physiology.** A comprehensive study of the physiological and biochemical interactions between the insect and its environment including: sensory mechanisms, attractants and repellants, nutritional specialization, intermediary metabolism, energy production and utilization, metabolic activity accompanying functional changes, process controls. 1 unit. Prerequisite: Entomology 422; Chemistry 350. Friedman, Larsen.

426. **Seminar in Entomology.** Discussions, reviews, and appraisals of special topics in the field of entomology. ¼ to 1 unit. Prerequisite: Entomology 302; consent of instructor. Fraenkel, Friedman, Horsfall, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer, Willis.

430. **Biological Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. Hall.

499. **Thesis Research.** Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and ecology of insects, insect toxicology, and insect physiology. 0 to 4 units. Fraenkel, Friedman, Ghent, Horsfall, Jaycox, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer, Willis.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Advanced Entomology, I.** With Entomology 302, this course provides the necessary background for all further advanced work in the department. Entomology 301 is devoted to integrated studies of the principal morphological and physiological characteristics of insects, and is to be followed by similar systematic studies in Entomology 302. 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalent. Friedman, Sternburg.

302. **Introduction to Advanced Entomology, II.** With Entomology 301, this course provides the necessary background for all further advanced work in the department. Entomology 302 presents a comprehensive survey of the systematics and phylogeny of the orders and principal families of insects, together with practical experience in identification of these taxa. 1 unit. Prerequisite: Entomology 301. Selander.

306. **Special Problems.** For students ready to take up some special investigation as the beginning of a thesis problem for an advanced degree. ¼ to 1 unit. Prerequisite: Any of the following: Entomology 131, 301, 302, 317, 319, 322, or Zoology 101 or 321. Fraenkel, Friedman, Ghent, Horsfall, Jaycox, Kearns, Larsen, Ross, Selander, Sternburg, Waldbauer, Willis.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; organic chemistry; or consent of instructor. Alger, Silverman.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. Alger, Silverman.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelation with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent.

317. **Classification of Insects.** Advanced study of the systematics and phylogeny of selected insect groups, with a presentation of the principles and methods of systematic entomology. 1 unit. Prerequisite: Entomology 302. Selander.

319. **Fundamentals of Insect Control.** The course emphasizes the principles that underlie effective control practices, rather than the details of methods used against specific pests. Both environmental and chemical factors involved in insect control are considered from their basic aspects. 1 unit. Prerequisite: Zoology 101, Botany 100, and Chemistry 101, or equivalent. Horsfall, Kearns.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. 1 unit. Prerequisite: Entomology 101, 103, or 301, or Zoology 320. Horsfall.

361. **Individual and Group Behavior of Honey Bees.** See Horticulture 361. ½ unit. Prerequisite: One semester of entomology or zoology. Jaycox.

Microbiology

The Department of Microbiology offers graduate work leading to the Master of Science and Doctor of Philosophy. Students electing microbiology as a major for an advanced degree must have had, in addition to formal training in general bacteriology or microbiology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these requirements may apply for admission if they have a grade-point average of at least 4.0.

Candidates for the Master of Science must pass a general comprehensive examination.

MOLECULAR BIOLOGY (Biophysical Chemistry)

The Department of Microbiology in collaboration with the Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the doctoral candidate with basic training in physical biochemistry and biology. Students electing this area should possess a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interests of the student. It is expected, however, that he will fulfill minor requirements in physical chemistry or biochemistry.

Courses in the Department of Microbiology directly relevant to this program are Microbiology 330, 351, and 405. Courses in the Department of Chemistry and Chemical Engineering especially related to this curriculum are Chemistry 346, 452, 494.

The major research areas are: (1) molecular basis of gene function; (2) structures and activities of proteins and nucleic acids; (3) intracellular organization and distribution of nucleoprotein components; (4) biosynthetic mechanisms of macromolecular replication; (5) immunochemistry.

GRADUATE FACULTY

Professors: L. L. Campbell (Head of Department), K. C. Atwood, F. M. Clark, R. D. DeMoss, R. E. Kallio, S. Spiegelman, R. S. Wolfe.

Associate Professors: J. W. Drake, J. T. Wachsman, C. R. Woese, M. J. Wolin.

Assistant Professor: P. S. Sypherd.

COURSES FOR GRADUATES

402. **Molecular Genetics.** Same as Botany and Zoology 402. The nature of the gene, its mode of action, the mechanism of autosynthesis, the organization of the genetic

material, and the regulation of gene action. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. **Microbiological Genetics.** Same as Botany and Zoology 405. Breeding systems and recombinational analysis in microorganisms, with particular emphasis on protozoa and fungi. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Speigelman.

411. **Discussion in Genetics and Cytogenetics.** Same as Botany and Zoology 411. ¼ unit. Drake, Kitzmiller, Laughnan, Nanney, Steffensen.

412. **Advances in Microbiology.** Discussions of current research in several areas of microbiology. Discussions cover the following areas: (a) general microbiology, (b) microbial physiology and metabolism, (c) immunochemistry, (d) molecular genetics. ¼ unit. May be repeated for a maximum of one unit. Prerequisite: Consent of instructor. Staff.

420. **Chemistry of Microbic Processes.** The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimulation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. ¾ unit. Prerequisite: Microbiology 309 or 330 and Chemistry 234 and 350, or equivalent; consent of instructor. DeMoss.

430. **Biology Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. Hall.

451. **Experimental Virology and Microbial Genetics.** Experiments on the biology, replication, and genetics of bacteriophages and bacteria, with emphasis on experimental design by the students. 1 unit. Prerequisite: Microbiology 351; consent of instructor. Drake.

490. **Individual Problems.** ½ to 2 units. Prerequisite: Consent of instructor. Staff.

495. **Seminar.** Required of all graduate students whose major is microbiology. 0 or ¼ unit. Prerequisite: Ten hours of microbiology; consent of instructor. Staff.

499. **Thesis Research.** 0 to 4 units. Atwood, Campbell, Clark, DeMoss, Drake, Gunsalus, Kallio, Spiegelman, Wachsman, Woese, Wolfe, Wolin.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; organic chemistry; or consent of instructor. Alger, Silverman.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. Alger, Silverman.

309. **Cultivation and Properties of Microorganisms.** Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, cultivation of bacteria, and microbiological assays. 1 unit. Prerequisite: Organic chemistry, with biochemistry recommended; consent of instructor. Wolfe, Wolin.

311. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation and to industrial fermentation and processing and to sanitation. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201 or 309, or equivalent, and credit or registration in organic chemistry; or consent of instructor. Clark.

312. **Techniques of Applied Microbiology.** A consideration, through experimentation, of the properties of the bacteria, yeasts, molds, and actinomycetes which

are important to industrial processes. The methods of control of microbial processes in industry and sanitation are explored. Laboratory. ½ unit. Prerequisite: Credit or registration in Microbiology 311. CLARK.

326. **Pathogenic Bacteriology.** A study of the parasitism and pathogenic microorganisms: classification, morphology, cultural requirements and reactions, toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lectures and laboratory. 1 unit. Prerequisite: Microbiology 101 or 201, or 309; organic chemistry. MCCAMISH.

327. **Immunochemistry.** A survey of the field of immunology with emphasis on its chemical aspects. Lectures and laboratory. 1 unit. Prerequisite: Credit or registration in biochemistry or consent of instructor.

330. **Metabolic Regulation and Genetics of Microorganisms.** Modern contributions to the science of microbiology, including considerations of the micro- and macromolecular anatomy of the bacterial cell, the physiological and genetic behavior of microorganisms, and the role of bacterial viruses as agents involved in the transfer of genetic information. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201, or equivalent; credit or registration in biochemistry or consent of instructor; calculus strongly recommended. SYPHERD, WOESE.

351. **Viruses.** The study of viruses as a branch of microbiology. Statistical, physical, and chemical properties of virus particles; analysis of host-virus interaction; origin and natural relations of viruses. ¾ unit. Prerequisite: Organic chemistry; biochemistry recommended. DRAKE.

Physiology and Biophysics

The Master of Science and Doctor of Philosophy are granted in both physiology and biophysics.

Physiology

Admission to graduate study in physiology requires a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Applicants should submit three letters of recommendation, a letter regarding intentions and qualifications, and, if possible, scores on the Graduate Record Examination. There is no departmental requirement of specific undergraduate major or minor fields, but the student whose background is deficient in chemistry, mathematics (including calculus), physics, or biological sciences (including morphology and genetics) must rectify these deficiencies early in his graduate career. Students who have not had a laboratory course in physiology should take Physiology 301 or 302 before they enter the graduate courses in advanced physiology.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in physiology and related subjects. Ordinarily, the program includes Physiology 401, 402, 403, and 404, two units from related departments, and two units of Physiology 491. A research paper based on Physiology 491 must be submitted. Candidates for the Master of Science must pass a general oral examination.

Doctor of Philosophy. Admission to candidacy is based on a qualifying examination after completion of eight units or the Master of Science.

The department requires that the candidate pass a written comprehensive examination covering important areas of physiology before he is permitted to take his oral preliminary examination.

Each candidate must take, either as an undergraduate or as a graduate student, the following courses or their equivalents: Physiology 401, 402, 403, and 404 (com-

bined mammalian, cellular, and comparative physiology); Chemistry 340 or 342 and 344; Chemistry 350 and 355; a course in statistics at the graduate level; and a course in the history and/or the philosophy of science. At some time during the doctoral program, the candidate will be expected to teach for two semesters at half time (or the equivalent).

In addition to satisfying the above requirements for all students, each candidate specializes in one of the following areas: mammalian physiology, comparative physiology, cellular physiology, endocrinology, neurophysiology, human anatomy and human physiology, bioclimatology and environmental physiology, radiobiology. An intradepartmental minor may be offered in most of these areas of specialization, chosen from sequences other than Physiology 401, 402, 403, and 404.

Minor. Graduate students in other departments are assigned by the physiology graduate student counselor to a departmental minor adviser according to their interests. Requirements are as follows: sole minor, four units including two from the 401-404 sequence; split minor, two units of which one is at 400-level. A sequence of courses within one area of physiology is desirable for a minor.

Biophysics

The objective of the program in biophysics is to give the student sufficent training in physics, chemistry, and biology to enable him to apply the conceptual, instrumental, and mathematical approaches of the physical scientist to the solution of biological problems. The graduate curriculum is administered by a committee representing both the physical and the biological sciences. The curriculum is designed primarily for students entering with a master's degree in a physical science but students with less than a master's degree in physical sciences or biology may be eligible.

Admission requirements for the latter are one year of college biology, one year of college physics, quantitative analysis (five hours), organic chemistry (five hours), and calculus (six hours). However, any deficiencies can be corrected while in training. Applicants must have a grade-point average of at least 4.0.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in biophysics and related subjects. The required courses are Biophysics 401, 402, and two units of additional biophysics courses, a thesis, or special field examination.

For students whose major training has been in the physical sciences, the balance of courses should be selected from the biological science courses; students from the biological sciences select courses from the physical science courses. Candidates for the Master of Science must pass a general examination.

Doctor of Philosophy. A flexible approach is made to curriculum requirements. Students are required, after approximately eight units of graduate study, to pass a qualifying examination, and after sixteen units, to pass a preliminary examination. At some time during the doctoral program, the candidates will be expected to teach for two semesters at half time (or the equivalent). An acceptable course program is given below:

(1) Mathematics, physics, and chemistry: Mathematics 343 or 345; Physics 321, 341, 342, and 381; Chemistry 342, 343, 344, and 345 (a one-year sequence including lectures and laboratory), and Chemistry 350 and 355. Certain of the required physics courses can be waived, upon approval of the committee, in cases where the student has had comparable training in advanced courses in physical chemistry. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is necessary for work in biophysics.

(2) Biology: Three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. At least one course in genetics should be included as part of the three-unit requirement in biology.

(3) Biophysics: Biophysics 401 or equivalent; Biophysics 402 and two additional courses in biophysics (other than research).

(4) Minor areas: Students entering from the biological sciences may declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet the approval of the committee.

Minor. Subject to the approval of the committee, candidates for the Doctor of Philosophy in other fields may take a minor in biophysics.

GRADUATE FACULTY

Professors: C. L. Prosser (Head of Department), B. C. Abbott, H. W. Ades, J. D. Anderson, W. R. Ashby, H. S. Ducoff, F. Dunn, R. E. Johnson, A. V. Nalbandov, E. I. Rabinowitch, F. Sargent II, F. R. Steggerda, A. B. Taylor, H. I. Teigler, G. J. Thomas, H. M. Von Foerster.

Associate Professors: D. E. Buetow, J. Gorski, Govindjee, B. A. Hertig, J. R. Larsen, S. G. Stolpe, J. S. Willis.

Assistant Professors: J. H. Heath, E. S. Kirk.

Physiology

COURSES FOR GRADUATES

401. **Physiology of Systems and Organs.** Analysis of organization and function of vertebrate systems, combining the viewpoints of traditional cellular, comparative, mammalian, and human physiology; nervous, circulatory, digestive, and excretory systems; gross metabolism. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

402. **Comparative and Adaptational Physiology.** Analysis of mechanisms of adaptation to the environment and to environmental stress, combining the viewpoints of traditional cellular, mammalian, and human physiology, with particular emphasis on the comparative approach. Homeostatic theory, nutrition, osmotic and ionic regulation and cell membranes, respiration and metabolism, temperature relations, bioelectrics, contractile systems. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

403. **Cellular and Molecular Physiology.** Physicochemical analysis of cellular function and consideration of the implications of the properties of cells for the physiology of multicellular animals. Cell and its organization, cell and the organism, protein structure and specificity, regulation of cell metabolism, cellular basis of hormone action, photobiology. 1 unit. Prerequisite: One year of college-level physics; chemistry including physical and biochemistry; an upper division course in physiology; knowledge of calculus presumed. Staff.

404. **Physiological Measurements.** Lectures and laboratories concerned with an introduction at a graduate level to current research techniques in the physiological sciences. The laboratories are problem-oriented, and students select four to six special topics, at least one of which must be in each of the following major areas of physiology: (1) nervous system and muscles; (2) mammalian and human; (3) adaptation and radiation biology, and comparative physiology; (4) molecu-

lar, cellular, and endocrinological physiology. Within each area there are problems which fall into one or more of the following experimental categories: electrical-mechanical, chemical, and surgical. Selection of problems is done in conjunction with the course secretary so that the student obtains familiarity with techniques in each of these experimental categories and can devote some time to material of consequence relating to his own research interests. Emphasis is placed on the ability to work independently, and students give oral and written reports of their experimentation. 1¼ units. Prerequisite: Chemistry 355 or equivalent, or consent of instructor. STAFF.

410. **Mammalian Physiology Seminar.** Current trends in mammalian physiology. ½ unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. KIRK, STEGGERDA.

412. **Advanced Endocrinology.** Same as Animal Science, Dairy Science, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. The course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. GORSKI, NALBANDOV.

413. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

414. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. ADES.

421. **Gross Human Anatomy.** A general survey of the structures of the human body with emphasis on the relations between form and function. 1 unit. Prerequisite: One semester of embryology; consent of instructor. STOLPE.

425. **Quantitative Neuroanatomy Lecture.** Same as Electrical Engineering 425. A detailed consideration of (1) quantitative methods of studying structure in the central nervous system, (2) analysis of quantitative data concerning cell and fiber populations and related characteristics in both normal and modified brains, and (3) derivation of neuronal circuitry. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor. ADES, FRY.

426. **Quantitative Neuroanatomy Laboratory.** Same as Electrical Engineering 426. Practice in the use of quantitative methods for precisely determining nerve cell populations and other components of the central nervous system and in measuring properties of subcellular components of anatomic significance. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor. ADES, FRY.

430. **Biological Ultrastructure.** See Zoology 430. 1 unit. Prerequisite: Consent of instructor. HALL.

431. **Experimental Radiobiology.** Laboratory exercises in irradiation procedures and in the examination of biological responses to ionizing radiations. 1 unit. Prerequisite: Physiology 331 or equivalent; consent of instructor. DUCOFF.

441. **Advanced Comparative Physiology.** Same as Zoology 441. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** Same as Zoology 442. Laboratory experiments presenting comparative principles in osmotic and ionic regulation, respiration and metabolism, temperature regulation of animals, physiology

of circulatory systems, of muscle, of sense organs and nervous systems. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441. PROSSER.

451. Advanced Cellular Physiology. Same as Zoology 451. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

461. Fundamentals of Bioclimatology. Same as Geography 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor. ARMSTRONG, SARGENT.

462. Experimental Bioclimatology. Same as Geography 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Physiology 461. ARMSTRONG, SARGENT.

464. Advanced Human Bioclimatology. Same as Geography 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Physiology 461. ARMSTRONG, SARGENT.

470. Human Pathologic Physiology. Disturbances of function in tissues and organs and their relationship to the pathogenesis of human disease. ¾ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

472. Human Physiology Seminar. Topics of current emphasis in human physiology. ½ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

491. Individual Topics. For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Approval of department. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

Research may be conducted in the following areas, with the consent of the instructor:

(a) Cellular Physiology and Radiobiology. ABBOTT, ANDERSON, BUETOW, DUCOFF, PROSSER, TAYLOR.

(b) Comparative Physiology. ABBOTT, ANDERSON, HEATH, LARSEN, PROSSER, WILLIS.

(c) Mammalian Physiology. NALBANDOV, STEGGERDA.

(d) Human Anatomy and Human Physiology. JOHNSON, STOLPE.

(e) Endocrinology. GORSKI, NALBANDOV, STOLPE.

(f) Neurophysiology. ADES.

(g) Bioclimatology. SARGENT.

(h) Environmental and Stress Physiology. HERTIG, JOHNSON, SARGENT.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. General Physiology. Same as Zoology 301. A consideration from the standpoint of experimental biology of functions that are common to most living organisms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics, and physics; chemistry through organic. ANDERSON, STAFF.

302. **Experimental Animal Physiology.** Same as Zoology 302. Organ physiology of animals with emphasis on homeostasis and physiological interactions of animals with their environment. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic. Anderson, Staff.

304. **Principles of Ergonomics.** Same as Industrial Engineering 304. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. 1 unit. Prerequisite: Consent of instructor.

305. **Quantitative Methods in Ergonomics.** Same as Industrial Engineering 305. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. 1 unit. Prerequisite: Physiology or Industrial Engineering 304.

307. **Immunobiology.** See Zoology 307. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; organic chemistry; or consent of instructor. Alger, Silverman.

308. **Experimental Immunobiology.** See Zoology 308. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. Alger, Silverman.

312. **Endocrinology.** Same as Zoology 312. The glands of internal secretion with special reference to the vertebrates. ¾ unit. Prerequisite: Physiology or Zoology 301, or a course in biochemistry; consent of instructor. Gorski.

313. **Experimental Endocrinology.** Same as Zoology 313. Laboratory techniques and project in endocrinology. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. Gorski.

331. **General Radiobiology.** Responses of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. Ducoff.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. Shimkin, Staff.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multi-disciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. Levine, Staff.

Biophysics

COURSES FOR GRADUATES

401. **Advanced Biophysics, I.** Topics from electrobiology, muscle biophysics, and physical properties of biological media. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry; or consent of instructor.

402. **Advanced Biophysics, II.** Photobiology, including photosynthesis, bioluminescence, and visual reception. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry.

403. **Biophysical Techniques.** This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microscopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. ½ or 1 unit. Prerequisite: Credit or registration in Biophysics 402, or consent of instructor. DUNN, MATSUMOTO.

410. **Special Topics in Biophysics.** An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. ½ to 1 unit. Prerequisite: Biophysics 401 or equivalent; Biophysics 402 and 403.

411. **Seminar.** Survey of the literature in one area of biophysics, with special emphasis on student reports. ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor.

435. **Fundamentals of Cybernetics.** Same as Communications 435 and Electrical Engineering 473. The study of large dynamic systems insofar as they are brain-like; the living brain as a computer; processes of regulation and computation when the quantity of information processed becomes obtrusively large. 1 unit. Prerequisite: Electrical Engineering 304 or Mathematics 361, or consent of instructor. ASHBY.

436. **Problems of Cybernetics.** Same as Communications 436 and Electrical Engineering 474. Continuation of Biophysics 435. The further study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Biophysics 435. ASHBY.

463. **Radioisotopes in Biological Research: Principles and Practice.** See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor.

491. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. 0 to 4 units.

(a) **Bioacoustics.** DUNN.

(b) **Cellular Physiology.** BUETOW.

(c) **Electrobiology.** ABBOTT, PROSSER.

(d) **Photosynthesis.** GOVINDJEE, RABINOWITCH, SYBESMA.

(e) **Microbiology.** SPIEGELMAN, WOESE.

(f) **Physics of Muscular Contraction.** ABBOTT.

(g) **Radiobiology.** DUCOFF.

(h) **Information Theory and Cybernetics.** ASHBY, VON FOERSTER.

(i) **Ion Transport and Permeability.** ABBOTT.

(j) **Mechanical Properties of Tissues.** GILMAN.

(k) **Vascular Dynamics.** KIRK.

(l) **Central Nervous System.** ADES.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Biophysics. A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. ¾ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program.

312. Introduction to Radiobiology. Nature and mechanisms of the biological consequences of low dose and chronic irradiation. Intended primarily for students in engineering and physical sciences. ½ unit. Prerequisite: Mathematics 142 or 143; eight hours of physics; consent of instructor.

Zoology

The Department of Zoology offers work leading to the Master of Science and Doctor of Philosophy. Five areas of specialization are available: vertebrate zoology; invertebrate zoology; embryology and basic knowledge of cells and tissues; ecology, natural history, and taxonomy; genetics, phylogeny, and evolution.

The grade-point average for admission is 4.0. Applicants with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Applicants should have approximately twenty-five hours of zoology and two semesters each of chemistry, physics, and mathematics. Knowledge of two foreign languages is necessary, and two of the following are recommended: French, German, Russian; Latin and Greek also are helpful.

The Master of Science requires eight units of graduate credit, an acceptable thesis or research report, and, at the end of the program, a successful oral examination. Candidates for this degree who have not had organic chemistry are required to take it, with no graduate credit. Calculus may be recommended.

Admission to advanced standing requires the master's degree or the equivalent and presupposes that the minimum science requirements specified for the master's degree have been met. Any deficiencies must be removed without graduate credit. Additional science requirements for the doctorate include at least one advanced course in physiology and statistics. Quantitative chemistry, biochemistry, and other courses may be recommended by the adviser or doctoral committee. Prior to admission to the oral preliminary examination each applicant must spend a season at an approved marine biological laboratory and pass one formal course primarily concerned with marine invertebrate fauna, and pass the written proficiency examination in any three of the five areas of specialization within the department. The preparation of a satisfactory doctoral thesis and its defense at a final examination are required. It is also required that the results of the thesis investigation be presented at a departmental or sectional seminar. Further details relating to work in specialized areas in zoology and departmental requirements may be obtained by writing to the head of the department, 287 Morrill Hall.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology.

GRADUATE FACULTY

Professors: P. H. Silverman (Head of Department), R. S. Bader, G. W. Bennett, B. V. Hall, D. F. Hoffmeister, L. Ingle, S. C. Kendeigh, J. B. Kitzmiller, F. J. Kruidenier, N. D. Levine, A. V. Nalbandov, D. L. Nanney, C. L. Prosser, G. C. Sanderson, H. M. Smith, P. W. Smith, R. L. Watterson.

Associate Professors: E. M. Banks, D. C. Eades, A. W. Ghent, M. R. Matteson, H. H. Shoemaker.

Assistant Professors: Nelda E. Alger, E. H. Brown, R. Davenport, T. H. Frazzetta, G. L. Freeman, C. E. King, M. R. Lee, E. B. Small, D. C. Sweeney, Mary F. Willson.

COURSES FOR GRADUATES

402. **Molecular Genetics.** See Microbiology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. **Microbiological Genetics.** See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

406. **Physiology of Reproduction.** Same as Animal Science 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. Nalbandov.

407. **Evolutionary Theory.** Genetic, systematic, ecological, and zoogeographical concepts as related to the process of evolution. 1 unit. Prerequisite: One course in genetics or consent of instructor. Bader.

408. **Laboratory Methods in Physiology of Reproduction.** Same as Animal Science 408. ½ to 1 unit. Prerequisite: Consent of instructor. Nalbandov.

411. **Discussions in Genetics and Cytogenetics.** Same as Botany and Microbiology 411. ¼ unit. Brown, Drake, Kitzmiller, Laughnan, Nanney, Steffensen.

412. **Advanced Endocrinology.** See Physiology 412. Course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. Gorski, Nalbandov.

418. **Advanced Protozoology.** Advanced consideration of selected topics, with emphasis on laboratory practice in modern methods and techniques of studying both free-living and parasitic protozoa: collecting, culturing, and staining of representative forms. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Zoology 318 or equivalent. Small.

419. **Topics in Experimental Protozoology.** Consideration of the advantageous employment of protozoa in modern researches concerned with basic biological problems; selected experimental topics covered by lectures, demonstrations, discussions, reports, and readings. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. Small.

420. **Experimental Invertebrate Zoology.** Study of current research problems and practice in the experimental methods used in the area of invertebrate zoology. 1 unit. Prerequisite: Zoology 320 or equivalent; consent of instructor. Sweeney.

421. **Cytogenetics.** See Botany 421. 1 unit. Prerequisite: Zoology 210, or Microbiology 330, or consent of instructor. Steffensen.

422. **Advanced Parasitology.** Advanced study of modern methods in helminthology. 1 unit. Prerequisite: Zoology 321 or equivalent. Kruidenier.

423. **Electron Microscopy.** See Biology 423. ¼ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; consent of instructor. Hall.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Zoology 304. Matteson.

425. **Experimental Parasitology.** Same as Veterinary Medical Science 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. Levine, Silverman.

429. **Electron Microscopy Laboratory.** See Biology 429. ½ or ¾ unit. Prerequisite: An adequate background in chemistry, physics, and mathematics; credit or registration in Zoology 423; consent of instructor. Hall.

430. **Biological Ultrastructure.** Same as Entomology, Microbiology, and Physiology 430. Lectures and reports on the fine structure of plant and animal cells and cell products with discussions of possible relationships of ultrastructure to function and of diverse interpretations of chemical-physical information as ultrastructure. 1 unit. Prerequisite: Consent of instructor. HALL.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. May be elected in successive years. ½ unit. Maximum credit for master's candidates, one unit; for doctoral candidates, three units. Prerequisite: Zoology 333 and 367. WATTERSON.

441. **Advanced Comparative Physiology.** See Physiology 441. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** See Physiology 442. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441.

444. **Concepts in Ethology.** Group discussion of problems such as stimulus filtering, spontaneity, and stereotyped motor patterns, with a new topic each semester. ½ unit. Prerequisite: Zoology 346.

445. **Advanced Ecology and Wildlife Management.** Seminar on modern techniques, concepts, and problems. ½ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Zoology 345 or equivalent. KENDEIGH.

446. **Physiological Ecology.** Physiological adjustments and responses of organisms to their environment. 1 unit. KENDEIGH.

451. **Advanced Cellular Physiology.** See Physiology 451. ½ unit. Prerequisite: Consent of instructor. STAFF.

467. **Experimental Embryology.** 1 unit. Prerequisite: Zoology 367. FREEMAN, WATTERSON.

490. **Individual Research.** For master's degree candidates who elect to write a research report rather than a thesis. No more than three units may be included in the master's degree program. ½ to 3 units. Prerequisite: Consent of adviser. STAFF.

499. **Thesis Research.** 0 to 4 units. Work in the following fields is offered for students registered in Zoology 499:

Anatomy, Physiology, and General Classification of Vertebrates: Vertebrate Anatomy, H. SMITH; Endocrinology, HALL, NALBANDOV; Functional Anatomy, FRAZZETTA; Histology, DAVENPORT; Ultrastructure, HALL; Vertebrate Physiology, PROSSER.

Anatomy, Physiology, and General Classification of Invertebrates: Helminthology, KRUIDENIER, SILVERMAN; Invertebrate Zoology, MATTESON, SWEENEY; Invertebrate Physiology, ALGER, KRUIDENIER, PROSSER, SILVERMAN, SWEENEY; Protozoology, SMALL.

Embryology and Basic Knowledge of Cells and Tissues: Cytology, DAVENPORT; Embryology and Regeneration, DAVENPORT, FREEMAN, WATTERSON; Toxicology, INGLE.

Principles of Ecology, Principles of Taxonomy, Natural History: Ecology, KENDEIGH; Ethology, BANKS; Herpetology, H. SMITH; Iohthyology, SHOEMAKER, P. SMITH; Limnology, BENNETT, MATTESON; Mammalogy, HOFFMEISTER, LEE; Ornithology, KENDEIGH, WILLSON; Wildlife Management, KENDEIGH, SANDERSON, SHOEMAKER.

Genetics, Phylogeny, Evolution: Genetics and Evolution, BROWN, DAWSON, KITZMILLER, NANNEY; Vertebrate Phylogeny and Paleontology, BADER, FRAZZETTA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students, but also open to seniors whose major is zoology. No credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Parasitology-Protozoology Seminar.

301. **General Physiology.** See Physiology 301. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics, and physics; chemistry through organic.

302. **Experimental Animal Physiology.** See Physiology 302. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic.

303. **Individual Topics.** For those who wish to study individual problems. Graduate students may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. ½ or 1 unit. Prerequisite: Two years of zoology; consent of department. STAFF.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and land and fresh-water invertebrates; habits and life histories of selected forms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. MATTESON.

305. **Principles of Systematic Zoology.** Theory and practice in proper procedure for formation and for determination of status names for classification of animal populations. ½ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. H. SMITH.

306. **Biology for Teachers.** See Botany 306. ½ unit. Prerequisite: Botany 100 and Zoology 104, or a year course in general biology.

307. **Immunobiology.** Same as Botany, Entomology, Microbiology, and Physiology 307. A survey of immune responses of vertebrates and invertebrates; the immunological relationships of protozoan and helminth parasites to their hosts; the influence of immune phenomena on development and evolution. Lecture. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; organic chemistry; or consent of instructor. ALGER, SILVERMAN.

308. **Experimental Immunobiology.** Same as Botany, Entomology, Microbiology, and Physiology 308. An introduction to laboratory techniques employed in the immunological investigations. Laboratory. ½ unit. Prerequisite: Credit or registration in Zoology 307; consent of instructor. ALGER, SILVERMAN.

310. **Principles of Population Biology, I.** The sequence Zoology 310 and 311 provides an integrated treatment of population concepts in biology. Major topics covered include: ecology, ethology, population genetics, and evolution. ¾ unit. Prerequisite: Zoology 210 or consent of instructor; college algebra.

311. **Principles of Population Biology, II.** Continuation of Zoology 310. ¾ unit. Prerequisite: Zoology 310 or consent of instructor.

312. **Endocrinology.** See Physiology 312. ¾ unit. Prerequisite: Zoloogy 301 or a course in biochemistry; consent of instructor. GORSKI.

313. **Experimental Endocrinology.** See Physiology 313. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. GORSKI.

318. **Protozoology.** Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SMALL.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SWEENEY.

321. **Parasitology.** Warm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KRUIDENIER.

324. **Vertebrate Paleontology.** Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Zoology 232 or Geology 102. BADER.

330. **Practical Microtechnique.** An introduction to microscopy, microphotography, and histological technique. ½ unit. Prerequisite: Histology or embryology and consent of instructor. ALGER, KRUIDENIER.

331. **Experimental Cytology.** See Botany 331. 1 unit. Prerequisite: Botany or Zoology 210 or Biology 151 and 251; consent of instructor; biochemistry is recommended. DAVENPORT, STEFFENSEN.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology; comparative anatomy, evolution, and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. 1 unit. Prerequisite: Zoology 232. FRAZZETTA.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. 1 unit. Prerequisite: Zoology 232. WATTERSON.

334. **Vertebrate Histology and Cytology.** Microscopic study of the cell, tissues, organs, and organ systems of the vertebrate body. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. DAVENPORT.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KENDEIGH, WILLSON.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. 1 unit. Prerequisite: Zoology 232. HOFFMEISTER, LEE.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. ½ unit. Prerequisite: Zoology 232. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Zoology 232. H. SMITH.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. WILLSON.

341. **Field Ecology.** During spring vacation, study of biotic communities, mammals, birds, reptiles, amphibia, fishes, and invertebrates in various sections of North America. Outdoor camping and cooking. Transportation in University cars. ¼ unit. Prerequisite: Credit or registration in one of the following: Zoology 304, 335, 336, 337, 338, 340, 345; consent of instructor. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management

policies for fish, mammals, and birds. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SHOEMAKER.

343. Limnology. Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. MATTESON.

345. Animal Ecology. Composition, dynamic development, and distribution of biotic communities. ¾ or 1 unit. Students enrolling for three-fourths unit are required to do field work on eight Saturdays; those enrolling for one unit are required to do field or laboratory work every Saturday, including one weekend camping trip; estimated expense, $8.50. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KENDEIGH.

346. Ethology. The behavior of animals as interpreted through comparative studies and experimentation. Laboratory consists of observation, experiments, occasional field trips, and an individual term project. Lecture, ½ unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratory enrollment. BANKS.

361. Individual and Group Behavior of Honey Bees. See Horticulture 361. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

367. Analysis of Development. Advanced study of basic problems in developmental biology. Major emphasis is placed on interactions at molecular, fine structural, and cellular levels and the genetic and metabolic mechanisms by which these interactions are controlled in plants and animals. Theories of differentiation are critically examined in the light of recent research. Lectures, discussions, outside readings, and student reports. 1 unit. Prerequisite: One course in each of the following areas: embryology, genetics, either cytology or histology, calculus, and organic chemistry; or equivalent. FREEMAN.

369. Introduction to Human Ecology. Same as Anthroplogy, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. KENDEIGH, SHIMKIN, STAFF.

375. Population and Community Ecology. Exposition of the populational viewpoint in animal ecology. Starting with the basic properties of populations, the discussion explores the growth and regulation of single-species populations, interactions between populations of different species, and properties of natural communities and interrelationships between ecological and evolutionary phenomena. ¾ unit. Prerequisite: Zoology 345 or equivalent; college algebra. KING.

380. Experimental Population Genetics. A survey of principles of population genetics and quantitative genetics, with particular emphasis on experimental aspects and current problems. ¾ unit. Prerequisite: Zoology 210 or equivalent; basic algebra. DAWSON.

LINGUISTICS

(Including Arabic, Burmese, Chinese, Hindi, Indonesian, and Japanese)

The Department of Linguistics offers a graduate program leading to the Master of Arts and Doctor of Philosophy. The following fields of linguistics are available for concentration: descriptive linguistics, historical linguistics, applied linguistics, inter-

disciplinary study in psycholinguistics, ethnolinguistics, experimental phonetics, and mathematical linguistics.

Undergraduate preparation for the study of linguistics should include the equivalent of at least three years of foreign language experience; for historical linguistics, a broad background in the humanities and social studies; and for descriptive linguistics, the equivalent of good undergraduate training in mathematics and the sciences. Students applying for admission should have at least a 4.0 grade-point average for that portion of the work which represents the last sixty hours earned toward the bachelor's degree. Applications of students with a grade-point average between 3.5 and 3.99 are considered on an individual basis.

Master of Arts. Candidates for this degree must earn eight units, of which six units must be in linguistics. At least two of the required units in linguistics must be chosen from 400-level courses and must include Linguistics 401, Linguistic Analysis, I.

In addition to fulfilling the general requirements of the Graduate College, the student must pass the reading examination in one foreign language, pass the comprehensive qualifying examination in general linguistics (and special subjects, if appropriate), and must submit a satisfactory master's essay to the department; admission to the qualifying examination is contingent upon success in the language examination.

Doctor of Philosophy. Candidates for this degree must complete at least twenty-four units of graduate work, or sixteen units beyond the master's degree. Eight of the minimum twenty-four units must be in Linguistics 499, Thesis Research. Students of descriptive linguistics must attain a grade of B or better in Linguistics 401, Linguistic Analysis, I, and Linguistics 402, Linguistic Analysis, II.

Students are encouraged to attend at least one summer session of the Linguistic Institute of the Linguistic Society of America. Up to four units of credit granted by the host university under this program may be transferred. Students of descriptive linguistics also are strongly urged to establish a vested interest and a firm basic foundation in some particular language or language family at as early a point as possible in their graduate career.

Candidates must demonstrate proficiency in two languages other than English and must pass the comprehensive qualifying examination (mentioned above for the master's degree), preferably after the first year of graduate work, unless they have already qualified for the Master of Arts in Linguistics.

Linguistically oriented courses in related departments may be counted toward the major if approved by the adviser. The head of the department acts as general adviser to each student until he selects his field of concentration, at which time he comes under the guidance of an adviser in his special area.

GRADUATE FACULTY

Professors: R. B. Lees (Head of Department), J. H. D. Allen, J. B. Casagrande, C. L. Dawson, H. R. Kahane, M. A. Morínigo, C. E. Osgood.

Associate Professors: Katharine O. Aston, F. K. Lehman, H. S Maclay.

Assistant Professors: F. M. Jenkins, B. B. Kachru, T. M. Lightner, J. Yegerlehner, W. R. Zemlin, A. M. Zwicky.

Linguistics

COURSES FOR GRADUATES

401. **Linguistic Analysis, I: Syntax.** Motivations for syntactic analysis; linguistic theories; critique of constituent-structure theories; introduction to mathematical linguistics; theory of transformational grammars; semantic theories of sentencehood. 1 unit. Prerequisite: Linguistics 300 or equivalent.

402. **Linguistic Analysis, II: Phonology.** Examination of language-specific phonological problems with a view toward formulating a language-independent theory of phonology. 1 unit. Prerequisite: Linguistics 401 or consent of instructor. LIGHTNER.

403. **Seminar in Linguistic Analysis.** Discussion of advanced topics of current interest in descriptive linguistics. 1 unit. May be repeated for credit with consent of instructor. Prerequisite: Linguistics 401. GEIS.

404. **Linguistic Analysis, III: Practicum.** Classroom- and homework-solving of assorted problems in syntactic and phonological analysis of many languages. 1 unit. Prerequisite: Linguistics 401 and 402.

407. **Advanced Topics in Mathematical Linguistics.** The hierarchy of automata and the hierarchy of grammars; equivalence theorems and undecidability theorems; recognition procedures. 1 unit. Prerequisite: Linguistics 307 or equivalent. ZWICKY.

411. **Methods in Historical Linguistics.** Advanced analysis of genetic comparison and reconstruction, linguistic borrowing, linguistic geography, etymology, and related topics. 1 unit. Prerequisite: Linguistics 302 or 315. KAHANE.

412. **Research Seminar in Historical Linguistics.** Research work in etymology, linguistic geography, and historical syntax. 1 unit. Prerequisite: Linguistics 411 or consent of instructor. KAHANE.

415. **Seminar in Indo-European Linguistics.** Discussion and research paper on topics in Indo-Eurpoean languages, their history, orgins, development, and migration. 1 unit.

419. **Contrastive Linguistics.** Same as Rhetoric 419. A critical survey of contemporary linguistic models with special reference to their relevance in preparing contrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-Western languages at different linguistic levels. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor.

424. **Linguistics and Communication.** Same as Communications 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. MACLAY.

425. **Psycholinguistics.** Same as Communications and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Communications and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. ½ or 1 unit. Prerequisite: Linguistics 425; consent of instructor. MACLAY, OSGOOD.

450. **Seminar in Ethnolinguistics.** Consideration of selected problems relating linguistic structure and language behavior to other aspects of culture. 1 unit. Prerequisite: Linguistics 370 or consent of instructor. YEGERLEHNER.

462. **Introduction to Romance Linguistics.** Same as French, Spanish, Italian, and Portuguese 462. Comparative and historical analysis of the Romance languages. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

473. **Seminar in Phonetics.** Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

475. **Experimental Phonetics, I.** Same as Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. **Experimental Phonetics, II.** Same as Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. **Measurement of Speech, I.** Same as Speech 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 475. ZEMLIN.

478. **Measurement of Speech, II.** Same as Speech 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 476. ZEMLIN.

490. **Special Topics in Linguistics.** Individual studies in the areas of linguistics not covered by regular course offerings. ½ to 2 units.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** Same as Anthropology 300. An introduction to the science of descriptive linguistics. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

301. **Introduction to General Phonetics.** An introduction to the main branches of general phonetics and phonological theory; emphasis on analysis of non-Western languages and research techniques. ½ unit.

302. **Comparative Linguistics.** An introduction to the historical aspects of language. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

303. **Non-Western Linguistic Structures.** Intensive study of linguistic structure of a selected non-Western language. May be repeated for credit with consent of instructor. 1 unit.

305. **Introduction to Applied Linguistics.** An introduction to the applications of general linguistic theory to the specific fields of stylistics, theory of translation, contrastive analyses, and the teaching and learning of foreign (and second) languages. Practical assignment work. ¾ unit. Prerequisite: Consent of instructor. KACHRU.

307. **Introduction to Mathematical Linguistics.** Principles of set theory, logic and formal systems, group theory, and automata theory; introduction to the formal theory of grammars. 1 unit. Prerequisite: Linguistics 300.

308. **Comparative Grammar of Greek and Latin.** See Greek 308. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

309. **Field Methods in Linguistics.** Same as Anthropology 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. LEHMAN, YEGERLEHNER.

310. **Advanced Field Methods in Linguistics.** Same as Anthropology 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 309 or equivalent. LEHMAN, YEGERLEHNER.

315. **Introduction to Indo-European Linguistics.** An introduction to the formation and spread of languages in the early stages of Indo-European civilation; methods of reconstruction and comparison. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences. TOVAR.

317. **Languages of the World.** Same as Anthropology 317. A survey of the main language families of the world from both genetic and typological points of view. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

325. **Introduction to Psycholinguistics.** Same as Communications 325. An introductory survey of psychological and linguistic approaches to the study of communication. 1 unit. Prerequisite: An introductory course in linguistics or psychology. MACLAY.

338. **Philosophies of Language.** Same as Philosophy 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

350. **Sociolinguistics.** A critical study of the sociologically oriented general linguistic theories with special reference to language varieties, language attitudes, language diversity, language standardization, linguistics geography, language and political roles (language loyalty). Emphasis on research methodology and techniques. Concentration on South Asia. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. KACHRU.

351. **Area Linguistics.** Introduction to area classification, linguistic convergence, and borrowing; the Southeast Asia *Sprachbund;* phonological, morphological, and syntactic convergence. 1 unit. Prerequisite: Linguistics 300.

370. **Language, Culture, and Society.** Same as Anthropology and Communications 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

375. **Speech Science, I.** Same as Speech 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Speech 109 or 301 or consent of instructor. ZEMLIN.

376. **Speech Science, II.** Same as Speech 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

380. **Introduction to Slavic Linguistics.** Same as Slavic 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit. DAWSON.

387. **The Structure of English.** Same as English 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit.

388. **Linguistics in Language Learning, I.** Same as Rhetoric 388. The application of linguistic methods in the learning of a second language, with special emphasis

on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language, or equivalent; consent of instructor. ASTON.

389. **Linguistics in Language Learning, II.** Same as Rhetoric 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Linguistics 388. ASTON.

Arabic

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Arabic, I.** First term of second year of work in the Arabic language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Arabic 202 or equivalent. ABDO.

304. **Intermediate Arabic, II.** Concentration upon ability to engage in reasonably fluent discourse in Arabic, on comprehensive knowledge of formal grammar, and on ability to read ordinary written Arabic. ½ unit. Prerequisite: Arabic 303 or equivalent. ABDO.

Burmese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Burmese, I.** Introduction to a wider variety of styles and contexts of discourse and usage. Written Burmese and an orderly view of Burmese grammar. ½ unit. Prerequisite: Burmese 202 or equivalent. LEHMAN.

304. **Intermediate Burmese, II.** Concentration upon ability to engage in active and reasonably fluent discourse in Burmese, on the grammar of sentence formation and ability to read ordinary Burmese texts. ½ unit. Prerequisite: Burmese 303 or equivalent. LEHMAN.

Chinese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Chinese, I.** First term of second year of work in Chinese language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Chinese 202 or equivalent. CHENG.

304. **Intermediate Chinese, II.** Concentration upon ability to engage in fluent discourse in Chinese, on comprehensive grammatical knowledge, and on ability to read any ordinary simple text in Chinese. ½ unit. Prerequisite: Chinese 303 or equivalent. CHENG.

305. **Advanced Chinese, I.** Reading and translation of graded selections from modern Chinese literary and journalistic writing. ½ unit. Prerequisite: Chinese 304 or equivalent. CHENG.

306. **Advanced Chinese, II.** Reading in modern Chinese literary and journalistic writings; introduction to classical Chinese to prepare students of modern Chinese

to understand classical forms and quotations occuring in vernacular text and to use dictionaries and reference works. ½ unit. Prerequisite: Chinese 305 or equivalent. CHENG.

Hindi

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Hindi, I.** First term of second year of work in the Hindi language, with drill for more advanced conversational fluency; introduction of a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Hindi 202 or equivalent. SUBBARAO.

304. **Intermediate Hindi, II.** Concentration upon ability to engage in reasonably fluent discourse in Hindi, on comprehensive knowledge of formal grammar, and on ability to read ordinary texts in Hindi. ½ unit. Prerequisite: Hindi 303 or equivalent. SUBBARAO.

305. **Advanced Hindi, I.** A detailed analysis of formal grammar of Hindi and concentration on readings from Hindi literature, especially the *Bhakti* period and the *Adhunik* period; a survey of the growth of main literary forms of Hindi; introduction to styles and registers of Hindi. All students are required to work at least one hour with a native informant and/or in the language laboratory. ½ unit. Prerequisite: Hindi 304 or consent of instructor. SUBBARAO.

306. **Advanced Hindi, II.** A survey of the history of Hindi language and literature and its more important dialects, e.g., Brajbhasha, Awadhi, etc.; readings from different periods of Hindi literature; introduction to main trends and influences on modern Hindi literature. All students are required to concentrate on a restricted area of Hindi language or literature for specialization, and to work with an informant for greater fluency in conversational and formal Hindi. ½ unit. Prerequisite: Hindi 305 or consent of instructor. SUBBARAO.

Indonesian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Indonesian, I.** First term of second year of work in the Indonesian language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Indonesian 202 or equivalent. YERGERLEHNER.

304. **Intermediate Indonesian, II.** Concentration upon ability to engage in reasonably fluent discourse in Indonesian, on comprehensive knowledge of grammar, and on ability to read ordinary written Indonesian. ½ unit. Prerequisite: Indonesian 303 or equivalent. YERGERLEHNER.

Japanese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Japanese, I.** First term of second year of work in the Japanese language, with drill for increased conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Japanese 202 or equivalent. MAKINO.

304. **Intermediate Japanese, II.** Concentration upon ability to engage in reasonably fluent discourse in Japanese, on comprehensive view of formal grammar, and on ability to read simple written Japanese. ½ unit. Prerequisite: Japanese 303 or equivalent. MAKINO.

305. **Advanced Japanese, I.** Course for advanced knowledge of Japanese with emphasis on reading. ½ unit. Prerequisite: Japanese 304 or equivalent. MAKINO.

306. **Advanced Japanese, II.** Course for advanced knowledge of Japanese with emphasis on reading. ½ unit. Prerequisite: Japanese 305 or equivalent. MAKINO.

MARKETING

Graduate work may be taken in the field of marketing for a major or a minor for the Master of Science and for the Doctor of Philosophy. To do major work in this field, a student must have a grade-point average of at least 4.0 and adequate undergraduate training in business and marketing, quantitative analysis, and the social sciences. The program of each student, including the selection of an appropriate minor, must be approved by the graduate adviser or head of the Department of Marketing.

GRADUATE FACULTY

Professors: R. FERBER, R. M. HILL, F. M. JONES, R. V. MITCHELL, H. G. WALES.

Associate Professors: D. M. SLATE (Head of Department), L. M. DEBOER, R. D. MILLICAN.

Assistant Professors: D. G. FREDERICK, J. L. SIMON.

COURSES FOR GRADUATES

401. **Marketing Principles and Problems.** Functional, commodity, and institutional methods of studying marketing with particular reference to the analysis and classifications of functions, commodities, and institutions. 1 unit.

402. **Marketing Methods and Problems.** Selected problems in the operation and management of market institutions. 1 unit.

407. **Prices and Price Policies.** An examination of the role of prices in our economy; of pricemaking under conditions of competition, monopoly, or monopolistic competition, with special emphasis on nonprice competition; an examination of business pricing policies and of their acquisitive and social implications and significance. 1 unit.

415. **Merchandising Trends and Problems.** The literature, trends, policies and organization problems involved in retail merchandising. 1 unit.

416. **Merchandising Policies and Problems.** The policies and problems relating to merchandise control, personnel, publicity, and promotion; recent literature and legislation. 1 unit.

421. **Analysis of Consumer Markets.** A study of consumers and their demands. 1 unit.

422. **Advanced Marketing Research.** Advanced marketing research theory, literature, objectives, techniques, and problems of marketing research. 1 unit.

471. **The Development of Marketing.** The development of marketing organizations, problems, and methods in the United States from colonial times to the present; wholesaling, retailing, market growth, consumer buying habits, advertising, selling, pricing, legislation, trade channels. 1 unit.

472. **Sales Campaigns.** Problems in managing the sales force. 1 unit.

493. **Research in Special Fields.** ¼ to 2 units.

499. **Thesis Research.** Thesis or independent study in the field of marketing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: Marketing majors do not receive graduate credit for courses in the 300 series.

320. **Marketing Research.** An investigation of the development and applicability of information systems techniques to marketing problems. The marketing management process is analyzed; the underlying concepts related to the information needed to serve the processes are explored; and the incorporation of information resources into the management function is demonstrated. This course covers the use of behavioral sciences research methods, social processes and structure influences upon marketing activities, demographic variables, application of Bayesian decision theory, studies of promotional activity, simulation and programming models, planning models, and strategy formulation models which provide an analytical structure for the solution of marketing problems. ½ unit. Prerequisite: Marketing 201.

337. **Advertising and Sales Management.** Designed to enable the student, through directed and superivised investigation of selected psychological, economic, and sociological problems, to become acquainted with the methods of demand analysis and its application to the interrelationships of marketing management, advertising management, and sales management. Discussion of communication theory as it relates to the goals and means of winning patronage for the firm. Emphasis is on the effect, or control, of the communication process. Class discussion is focused upon literature in demand stimulation and communications and the testing of relevant hypotheses. ½ unit. Prerequisite: Marketing 201.

344. **Consumer Market Behavior.** An analysis of consumer motivation, buying behavior, market adjustment, and product innovation, including a survey of explanatory theories of consumer market behavior and producer reactions. This course covers behavioral aspects of the marketing process from the producer to ultimate user, or consumer. Fundamentals of product planning, development, engineering, and promotion are viewed as part of the total marketing program. Normative models of the decision-making process for winning patronage in intermediate, industrial, and consumer markets are considered. The decision-making process by consumers is evaluated with reference to psychological drives used by producers, middlemen, and consumers. ½ unit. Prerequisite: Marketing 201.

352. **Pricing Policies.** The essential nature of marketing decisions and pricing, marketing organization and the pricing process, price theories and pricing models; contributions of operations research and behavioral sciences to pricing analysis; the relationship of pricing objectives, methods, strategies, and policies to market behavior and the goals of the firm. ½ unit. Prerequisite: Marketing 201.

360. **Marketing Logistics.** The ecology, analysis, and development of integrated distribution systems; the application of quantitative tools, economic analysis, transportation and marketing management in the analysis, and interpretation and design of the physical flow of goods through marketing network alternatives. Attention is given to the theory of market structures, transport networks, location, and cost control. Consideration is also given to site selection, warehousing, inventory management, logistic communications networks, and data control models. ½ unit. Prerequisite: Marketing 201.

370. **International Marketing.** The role of enterprise, comparative marketing, and transport institutions and systems, and comparative marketing organizations and systems of administration in selected foreign countries and the United States;

the managerial and operational problems of world enterprise, with emphasis on the role of ethnic and cultural differences in influencing marketing strategy. ½ unit. Prerequisite: Marketing 201; consent of instructor.

380. **Advanced Marketing Management.** The appraisal and diagnosis, organization and planning, action and control of commodity and product-service distribution, marketing analysis and systems, and demand stimulation; a survey of normative models for decision-making in a variety of marketing situations and systems; introduction to the behavioral theory of the firm and its application to different marketing targets, institutional settings, or market arrangements; discussion of the various analytical tools available to firms for appraising, diagnosing, organizing, planning, and formulating market strategies. Principles of behavioral sciences and quantitative techniques are emphasized. A terminal course that integrates the analysis of a wide range of marketing problems and situations. ½ unit. Prerequisite: Marketing 320 and 337.

Note: See also Business Administration 373, Electronic Data Processing for Business.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the Master of Arts or Master of Science in Mathematics and Doctor of Philosophy in Mathematics, Master of Science in the Teaching of Mathematics, and Master of Arts or Master of Science in Statistics and Doctor of Philosophy in Statistics. For information concerning applied mathematics, see page 273.

MATHEMATICS

For admission a beginning graduate student must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

A student should have had twenty-three hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and at least nine semester hours of more advanced work in one or more of the fields of algebra, geometry, topology, analysis, and number theory. The last requirement refers to courses equivalent to Mathematics 317-318, 327-328, 332-333, 347-348, 353-354, and 387.

Master of Arts or Master of Science in Mathematics. The departmental requirements for the master's degree in mathematics are as follows: of the eight units required for the degree, at least six must be in mathematics, at least three of them in approved 400-level courses. Mathematics 347-348 and at least one other basic year sequence at or above the intermediate level, normally one of the sequences 317-318, 327-328, 332-333, should be included. More than one-half of this last requirement should be fulfilled in previous undergraduate work. A master's thesis is not required.

Master of Science in the Teaching of Mathematics. Candidates for the Master of Science in the Teaching of Mathematics must earn four units in mathematics, two units in education, and two units in electives. To meet requirements for this degree, candidates must have completed, either as prerequisites to admission or as part of their graduate program, all of the following courses or their equivalents: Mathematics 302, 303, 306, 307, 317, 318, 343, 347. A student who has not completed at least two of these courses as an undergraduate can not expect to qualify for the Master of Science in the Teaching of Mathematics in one year. Required courses in education are History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of 3.75. Ap-

plications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for this degree is Professor Wilson M. Zaring, 303 Altgeld Hall. See pages 41 and 42.

Doctor of Philosophy in Mathematics. The departmental requirements for the Doctor of Philosophy are as follows: the major subject is to chosen from algebra, analysis, applied mathematics, geometry, logic, probability and statistics, topology; the student must choose two internal minors from this list, or one internal minor and one outside minor, or a full outside minor; the choice of the outside minor, whether split or full, must have the approval of the Department of Mathematics.

Before taking the preliminary examination, the student must present sixteen units or its equivalent with the approval of the department. Of these units, at least ten units must be in 400-level mathematics courses, except for a student with a full outside minor, eight such units suffice. The preliminary examination in mathematics is based on the student's major and internal minor subjects, but is also intended to test the student's breadth of knowledge in mathematics. In the case of a full or split outside minor, the minor department may give an independent examination, if it so chooses, or may establish other criteria for evaluation of the student's ability.

At least two 400-level courses are required for each internal minor. The following mathematics courses are typical of those which may be used to satisfy major or minor requirements, and are listed by fields. It is left to the discretion of the department, however, to decide which courses may be chosen to fulfill such requirements.

Algebra: 401-408, 415, 416, 422.
Analysis: 440-447, 449, 453-456, 468, 469, 487.
Applied Mathematics: 444, 455-460, 461, 463, 465, 487-489.
Geometry: 408, 420, 422-426, 428.
Logic: 410-413, 416.
Probability and Statistics: 451, 452, 461, 463, 470, 473, 474, 478.
Topology: 431-435, 438, 439.

Furthermore, Mathematics 490 and 493 may be used for major or minor requirements in all areas, subject to the approval of the department.

Every student who intends to work toward a degree of Doctor of Philosophy in mathematics is expected to take a written qualifying examination within one year after completing his requirements for the master's degree; this examination is based on topics covered in Mathematics 317, 318, 347, 348. Furthermore, each student is expected to take the preliminary examination within one year after completing sixteen units of graduate work. The department may relax the requirements in the preceding two sentences, if special circumstances so warrant.

The language requirement must be met by demonstrating a reading proficiency in any two of the following three languages: French, German, and Russian.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology. The program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee.

For admission to full standing, a beginning graduate student must have a grade-point average of not less than 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered in an individual basis. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is helpful. Students are admitted on limited status.

Master of Arts or Master of Science in Statistics. A candidate for the master's degree in statistics, in addition to satisfying the general requirements of the Graduate

College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 40 and 41), he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

Doctor of Philosophy in Statistics. The thesis for the Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics and one representing mathematics or a field of application.

A candidate for the Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315, 347, or equivalent; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Department of Mathematics and including all courses in statistics listed jointly by the Department of of Mathematics and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

Candidates for a Doctor of Philosophy taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

GRADUATE FACULTY

Professors: P. T. Bateman (Head of Department), R. G. Bartle, C. R. Blyth, W. W. Boone, D. L. Burkholder, S. S. Cairns, M. M. Day, J. L. Doob, D. B. Gillies, S. I. Goldberg, J. W. Gray, W. Haken, Mary-Elizabeth Hamstrom, M. H. Heins, A. Heller, F. E. Hohn, C. Ionescu Tulcea, P. W. Ketchum, R. G. Langebartel, H. Levy, C. W. Mendel, H. J. Miles, D. E. Muller, H. Osborn, R. E. Pingry, I. Reiner, L. A. Rubel, H. H. Schaefer, E. J. Scott, M. Suzuki, G. Takeuti, T. W. Ting, W. J. Trjitzinsky, H. E. Vaughan, J. H. Walter, R. A. Wijsman.

Associate Professors: R. B. Ash, R. L. Bishop, R. E. Block, P. G. Braunfeld, R. W. Carroll, Josephine H. Chanler, W. A. Ferguson, L. L. Helms, Alexandra Ionescu Tulcea, R. P. Jerrard, F. B. Knight, H. Paley, E. T. Parker, J. W. Peters, M. Rajagopalan, N. J. Rothman, J. J. Rotman, Jewell E. Schubert, E. C. Weinberg, W. M. Zaring.

Assistant Professors: J. R. Alexander, Jr., K. I. Appel, J. W. Armstrong, S. B. Bank, M. Barr, Felice D. Bateman, I. D. Berg, G. R. Blakley, R. W. Fossum, J. G. Harvey, R. P. Kaufman, Chin Pi Lu, L. R. McCulloh, T G. McLaughlin, C. F. Osgood, J. T. Parr, A. L. Peressini, Irma Reiner, T. T. Robinson, D. R. Sherbert, P. M. Weichsel, J. E. Wetzel, K. G. Witz, P. D. Zvengrowski.

COURSES FOR GRADUATES

401. **Second Course in Abstract Algebra, I.** The Noether isomorphism theorem for groups; permutation groups; simplicity of the alternating group; Jordan-Holder theorem; Euclidean rings; fundamental theorem of Galois theory. 1 unit. Prerequisite: Mathematics 317 and 318.

402. **Second Course in Abstract Algebra, II.** Wedderburn theorem on semi-simple rings; fundamental theorem of finitely generated Abelian groups (with application to canonical forms for matrices); Krull-Schmidt theorem; tensor products; exterior algebra. 1 unit. Prerequisite: Mathematics 401.

403. **Theory of Rings.** Ideal theory in commutative rings; structure of noncommutative rings. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

404. **Group Theory.** Structure of groups, derived groups, nilpotence and solvability, extensions and products. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

405. **Theory of Fields.** Further development of the theory of fields covering topics from valuation theory, ideal theory, units in algebraic number fields, ramification, function fields, local class field theory. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

406. **Homological Algebra.** An axiomatic treatment of the algebraic systems basic in toplogy. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

407. **Group Representation Theory.** Representation of groups by linear transformations, group algebras, character theory, modular representations. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

408. **Lie Groups.** 1 unit. Prerequisite: Mathematics 332, 404, 441.

410. **Logical Foundations of Mathematics, I.** A discussion of the logical and philosophical foundations of mathematics; considers propositional and first order functional calculi. 1 unit. Prerequisite: Mathematics 314, or 317, or 347, or Philosophy 333, or consent of instructor.

411. **Logical Foundations of Mathematics, II.** Continuation of Mathematics 410. Considers Henkin completeness theorem and Godel incompleteness theorem. 1 unit. Prerequisite: Mathematics 410.

412. **Recursive Function Theory.** Introduction to recursive functions, study of properties of recursive and recursively enumerable sets, degrees of unsolvability, and the implications of the Church-Turing thesis. 1 unit. Prerequisite: Mathematics 410 or consent of instructor.

413. **Set Theory.** Zermelo-Fraenkel axiomatic set theory; basic concepts in set theory such as ordinal, cardinal, and rank are considered. 1 unit. Prerequisite: Mathematics 410.

415. **Advanced Topics in the Theory of Groups.** 1 unit. Prerequisite: Consent of instructor.

416. **Advanced Topics in Abstract Algebra.** 1 unit. Prerequisite: Consent of instructor.

420. **Projective Geometry.** 1 unit. Prerequisite: Mathematics 328

422. **Algebraic Geometry.** 1 unit. Prerequisite: Mathematics 328.

423. **Differential Geometry.** 1 unit. Prerequisite: Mathematics 343.

424. **Riemannian Geometry.** Local and global properties of Riemannian manifolds. 1 unit. Prerequisite: Mathematics 423.

425. **Differentiable Manifolds, I.** Foundations of modern differential geometry, including multilinear algebra, exterior calculus, Stokes' theorem, Frebenius' the-

orem, affine connections, elements of Riemannian geometry and Lie groups, sheaves, cohomology of manifolds, the DeRham theorem, differentiable fiber bundles, the holonomy theorem, the Hodge theorem, elements of complex analytic manifolds. 1 unit. Prerequisite: Mathematics 318 and 332.

426. **Differentiable Manifolds, II.** See Mathematics 425 for description. 1 unit. Prerequisite: Mathematics 425.

428. **Topics in Geometry.** 1 unit. Prerequisite: Consent of instructor.

430. **Elementary Geometry from a Modern Viewpoint.** Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. **Algebraic Topology, I.** Continuation of Mathematics 333. Categories and functors, homotopy groups, singular homology, Kunneth theorem, products in cohomology. 1 unit. Prerequisite: Mathematics 333.

432. **Algebraic Topology, II.** Continuation of Mathematics 431. CW-complexes, Cech homology, duality, spectral sequences, and other topics. 1 unit. Prerequisite: Mathematics 431.

433. **Fibre Spaces.** 1 unit. Prerequisite: Consent of instructor.

434. **Combinatorial and Differential Topology.** 1 unit. Prerequisite: Consent of instructor.

435. **General Topology.** Separation; global and local compactness and connectedness; compactification and completion; function spaces; other topics. 1 unit. Prerequisite: Mathematics 332 or consent of instructor.

438. **Topics in Topology.** 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** 1 unit Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** Application of the elementary theory is made to the study of conformal mappings, Riemann surfaces, entire and meromorphic functions. 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. **Real Analysis, I.** Lebesgue measure on the real line, integration and differentiation of real functions, elementary applications to harmonic analysis. 1 unit. Prerequisite: Mathematics 347 or equivalent.

442. **Real Analysis, II.** Metric spaces, introduction to functional analysis, integration on general measure spaces. 1 unit. Prerequisite: Mathematics 441.

443. **Ordinary Differential Equations.** Existence, uniqueness, and continuation of solutions; topics selected from: the theory of linear differential operators, Sturm-Liouville theory, stability theory, qualitative theory of differential equations. 1 unit. Prerequisite: Mathematics 347 and a first course in ordinary differential equations.

444. **Partial Differential Equations.** 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable, II.** 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** Geometrical properties of Hilbert spaces; linear operators; the spectral theory for self adjoint and related operators. 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** Geometrical properties of Banach spaces; bounded linear operators; applications to analysis; linear topological spaces. 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** Properties of normed rings; representation as rings of continuous functions or rings of bounded operators; applications to spectral theory, harmonic analysis, etc. 1 unit. Prerequisite: Mathematics 318 and 446 or 477.

451. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 455.

457. **Advanced Numerical Analysis.** Same as Computer Science 457. Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequsiite: Computer Science or Mathematics 387 or consent of instructor.

458. **Numerical Solution of Partial Differential Equations.** Same as Computer Science 458. The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by iterative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Mathematics 455 or consent of instructor.

459. **Topics in Hydrodynamics.** 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

461. **Applied Stochastic Processes.** Introduction to topics such as spectral analysis, filtering theory, and prediction theory of stationary processes, Markov chains and Markov processes. 1 unit. Prerequisite: Mathematics 346 and 347.

463. **Information Theory.** Same as Computer Science and Electrical Engineering 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or Electrical Engineering 433.

465. **Topics in Automata Theory.** Same as Computer Science and Electrical Engineering 465. 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 392, or consent of instructor.

468. **Topics in Analysis.** 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision-making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to nonsequential and sequential decision-making in practice. 1 unit Prerequisite: Consent of instructor.

473. **The Theory of Testing Hypotheses.** Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. 1 unit. Prerequisite: Consent of instructor.

474. **The Theory of Estimation.** Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. 1 unit. Prerequisite: Consent of instructor.

478. **Topics in Statistics.** 1 unit. Prerequisite: Consent of instructor.

487. **Theory of Approximation.** Same as Computer Science 487. General approximation theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

488. **Topics in Applied Mathematics.** 1 unit Prerequisite: Consent of instructor.

489. **Seminar in Applied Mathematics.** 1 unit. Prerequisite: Consent of instructor.

490. **Reading Course.** 1 to 2 units. Prerequisite: Consent of instructor.

493. **Proseminar.** An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. 1 unit. Prerequisite: Mathematics 347; credit or registration in Mathematics 348.

499. **Thesis Research.** 0 to 4 units. Prerequisite: Consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Theory of Sets and the Real Number System.** This course deals with elementary naive set theory and the development of the integers, the rational numbers, and the real numbers; principal emphasis is upon the mathematical needs of the secondary teacher. 1 unit. Prerequisite: One year of calculus or consent of instructor.

301. **Fundamental Concepts of Algebra.** 1 unit. Prerequisite: One year of calculus or consent of instructor.

302. **Topics in Geometry.** Historical development of geometry, including tacit assumptions made by Euclid, Euclid's Fifth Postulate and its equivalents, and the discovery of non-Euclidean geometries; geometry as a mathematical structure; finite geometries; geometry as a study of invariants of set transformations; projective geometry; applications of group theory to geometry; vector geometry. 1 unit. Prerequisite: One year of calculus or consent of instructor.

303. **Advanced Aspects of Euclidean Geometry.** Selected topics from geometry as for example, circumcircle, nine-point circle, theorem on centroid and orthocenter, the construction of regular figures, isometries in the plane and space, rotations and translations, fixed points, ordered and affine geometries, geometry of inversive plane. 1 unit. Prerequisite: One year of calculus or consent of instructor.

305. **Teachers' Course.** A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic Topics suitable for presentation for superior high school students are also considered. ½ or 1 unit. Prerequisite: One year of calculus or consent of instructor.

306. **Selected Mathematical Topics for Secondary School Teachers, I.** This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

307. **Selected Mathematical Topics for Secondary School Teachers, II.** This course deals with the teaching of the following topics in high school mathematics: var-

iables in geometry; logic analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as a real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

311. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

312. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

314. **Introduction to Set Theory and Mathematical Logic.** In general, this course supplies the set-theoretic and logical preliminaries for graduate work in mathematics. Contents: sets, relations, and mappings; the notions of constant and variable; the integers; cardinal and ordinal numbers; Zorn's Lemma; the real numbers; informal account of the propositional calculus and first order functional calculus; informal account of various axiomatic theories. 1 unit. Prerequisite: One year of calculus.

315. **Linear Transformations and Matrices.** 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** 1 unit. Prerequisite: Mathematics 327.

332. **Introduction to Set Theory and Topology.** Informal set theory, cardinals, ordinals, Zorn's Lemma, axiom of choice, topology of metric spaces, introduction to general topological spaces, and other topics. 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Introduction to Algebraic Topology.** Fundamental group, complexes, homology, simplicial approximation, structure of Abelian groups, exact sequences, axioms for homology. 1 unit. Prerequisite: Mathematics 318, 332, or consent of instructor.

341. **Differential Equations.** 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** 1 unit. Prerequisite: Mathematics 341.

343. **Advanced Calculus.** 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** 1 unit. Credit is not given for both Mathematics 345 and 349. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** 1 unit. Credit is not given for both Mathematics 346 and 348. Prerequisite: Mathematics 347.

349. **Differential Equations and Orthogonal Functions.** An honors course for students with superior mathematical ability. Credit is not goven for both Mathematics 349 and 345. 1 unit. Prerequisite: Grade of B or higher in Mathematics 347; and, for undergraduates, registration in Mathematics 249.

350. **Topics in Pure Mathematics.** This is a survey course in pure mathematics for secondary school mathematics teachers. It deals with topics in number theory, topology, and analysis. 1 unit. Prerequisite: Consent of instructor.

351. **Topics in Applied Mathematics.** This is a survey course in applied mathematics for secondary school mathematics teachers. It deals with topics in the application of matrices to physical and social sciences, applications of Boolean algebra, game theory. 1 unit. Prerequisite: Consent of instructor.

353. **Elementary Theory of Numbers.** 1 unit. Prerequisite: One year of calculus.

354. **Elementary Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 or 353.

357. **Mathematical Models in the Social Sciences.** Uses many models drawn from the social sciences to motivate, illustrate, and give a unified development of topics in the following areas: linear algebra, graph theory, Markov chains, and linear and nonlinear systems of difference equations. 1 unit. Prerequisite: Mathematics 134 or equivalent.

361. **Theory of Probability.** 1 unit. Prerequisite: One year of calculus.

362. **Finite Differences.** 1 unit. Prerequisite: One year of calculus.

363. **Advanced Statistics.** 1 unit. Prerequisite: One year of calculus.

364. **Advanced Statistics.** 1 unit. Prerequisite: Mathematics 363.

366. **Theory of Probability.** Continuation of Mathematics 361. Topics covered may include random walks, Markov chains, branching processes, birth and death processes, and theory of Queues. 1 unit. Prerequisite: Mathematics 361 or 363.

371. **Actuarial Theory.** 1 unit. Prerequisite: One year of calculus. PETERS.

372. **Actuarial Theory.** 1 unit. Prerequisite: Mathematics 371.

375. **Nonparametric Inference.** Nonparametric tests of hypotheses concerning means, variances, regression, and correlation coefficients; methods, depending on ranks; the efficiency of nonparametric tests. 1 unit. Prerequisite: Mathematics 361 or 363.

381. **Vector and Tensor Analysis.** 1 unit. Prerequisite: Mathematics 343 or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

386. **Laplace Transforms.** 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Analysis.** Same as Computer Science 387. 1 unit. Prerequisite: Computer Science 101 and a course in differential equations, or consent of instructor.

388. **Mathematical Methods in Engineering and Science.** 1 unit. Prerequisite: Mathematics 343.

391. **Boolean Algebra and Switching Theory.** Same as Computer Science and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. ½ or 1 unit. Prerequisite: Consent of instructor.

392. **Introduction to Automata Theory.** Same as Computer Science and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems;

asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 391, or consent of instructor.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, is offered by various graduate departments in the sciences and engineering. A graduate student interested in applied mathematics should register as a major in the department of his choice. In consultation with his adviser he should plan a basic course of study which will serve as preparation for subsequent specialization and research in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design.

MECHANICAL AND INDUSTRIAL ENGINEERING

The Department of Mechanical and Industrial Engineering offers work leading to the Master of Science and Doctor of Philosophy. Advanced study and professional training are offered in the general fields of power, design, production, and industrial engineering.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements of the Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 4.0. The applications of those with grade-point averages below 4.0 but above 3.6 are individually reviewed by the graduate committee and admission is granted if credentials are satisfactory. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

Except under unusual circumstances the maximum number of credits which is permitted in any course whose number ends in 8 or 9 is three units toward the requirements for a master's degree. A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is then required.

For further information see *Notes on Graduate Study*, available from the Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the departmental chairman of the graduate committee, Professor Seichi Konzo.

GRADUATE FACULTY

Professors: H. H. Korst (Head of Department), H. D. Bareither, E. L. Broghamer, B. T. Chao, W. L. Chow, L. E. Doyle, G. W. Harper, W. S. Harris, E. F. Hebrank, J. A. Henry, W. L. Hull, S. Konzo, J. L. Leach, R. J. Martin, J. C. Miles, L. C. Pigage, E. I. Radzimovsky, D. G. Ryan, F. Seyfarth, S. L. Soo, W. F. Stoecker, K. J. Trigger.

Associate Professors: R. W. Adkins, W. E. Bair, J. C. Chato, R. G. Hering, B. A. Hertig, E. A. Jackson, D. H. Offner, L. D. Savage, Jr., R. P. Strout, B. F. von Turkovich.

Assistant Professors: A. L. Addy, A. M. Clausing, B. G. Jones, H. J. Zimmerman.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics and Transport Properties.** Thermodynamic and microscopic considerations for the prediction of properties. Caratheodory principle; relations between properties; microscopic description based on classical statistics; statistical equilibrium and trend toward equilibrium fluctuations; thermodynamics and transport properties; implication of wave mechanics. 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor. Soo.

402. **Irreversible Thermodynamics.** Statistical considerations based on wave mechanics; gases and relativistic modifications; radiation and high temperatures; solids and liquids, systems at low temperatures; reactive systems; electrical and magnetic properties; fluctuations and irreversible thermodynamics. 1 unit. Pre: requisite: Mechanical Engineering 301 or equivalent. Soo.

403. **Fundamentals of Combustion.** Same as Aeronautical and Astronautical Engineering 438. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Mechanical Engineering 305 or Aeronautical and Astronautical Engineering 216.

404. **Gas Dynamics.** Introduction to theoretical gas dynamics; properties of compressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multidimensional problems. 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Addy, Chow, Korst.

405. **Convective Heat Transfer.** Fundamentals of convective heat transfer; calculation of heat transfer within conductor and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. Chao, Clausing, Hering.

406. **Heat Conduction in Solids.** Fundamentals of heat conduction in isotropic and anisotropic solids; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques. 1 unit. Prerequisite: Mechanical Engineering 306, Mathematics 346, or consent of instructor. Chao, Hering.

407. **Selected Topics in Gas Dynamics.** Theoretical analysis of nonsteady processes including scavenging, pulse jet, shock tube, and complex compressor. Includes an introduction to high velocity laboratory techniques. 1 unit. Prerequisite: Mechanical Engineering 404. Chow, Korst.

408. **Laboratory Investigation in Thermodynamics.** Special investigations involving thermodynamics analysis, thermodynamic properties, and performance of physical and chemical systems. ½ to 1½ units. Prerequisite: One-year course in thermodynamics; one half-year course in power laboratory. Bair, Jackson, Soo.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigation in flow, metering, heat transfer, heat exchanger performance and design. ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. Addy, Bair, Chao, Chow, Clausing, Jones, Korst, Savage, White.

410. **Thermal Radiation.** Fundamentals of radiant energy transport in absorbing and non-absorbing media; pyrometry; applications to selected problems involving

combined energy transport mechanisms. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. CHAO, HERING.

421. Environmental Control. Physiological reactions of humans to thermal and atmospheric environments, principles of ventilation, air-handling systems, free-stream jets and air distribution, illumination, sound, and acoustics. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. STOECKER,,

423. Air Conditioning and Refrigeration. Load calculation, thermal system performance and optimization, static and dynamic control, industrial refrigeration absorption, thermoelectric, and cryogenic refrigeration. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. STOECKER.

428. Laboratory Investigations in Refrigeration. Special investigations in refrigeration. ½ to 1½ units. CHATO, STOECKER.

429. Laboratory Investigation in Heating and Air Conditioning. Special investigations in heating, ventilating, and air conditioning. ½ to 1½ units. Prerequisite: Two semesters of power laboratory or equivalent. CHATO, HARRIS, HERTIG, KONZO, STOECKER.

432. Theory of Rotary Compressors. Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbocompressors; regulation; rotary positive blowers. 1 unit. Prerequisite: Mechanical Engineering 205, 206, and 212; or Theoretical and Applied Mechanics 232; or Aeronautical and Astronautical Engineering 211. KORST.

438. Laboratory Investigations in Power Machinery. Special investigations in power machinery, such as turbines, engines, fans, and compressors. ½ to 1½ units. Prerequisite: One-year course in power laboratory. HEBRANK, HULL, STROUT.

441. Machine Design. A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper considerations of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, RYAN.

442. Linkage Synthesis. Geometry of constrained motion in two and three dimensions; application of mathematical and other techniques to the synthesis of mechanisms. 1 unit. Prerequisite: Mechanical Engineering 342 or consent of instructor. BROGHAMER.

443. Dynamics of Machinery. Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, flywheels; special topics. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, RYAN.

445. Design of Internal Combustion Engines. Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. Laboratory Investigations in Machine Design. Special investigations in machine design. ½ to 1½ units. ADKINS, BROGHAMER, LARSON, OFFNER, RADZIMOVSKY.

451. **Theory of Metal Cutting.** A study of the theoretical factors involved in metal cutting and forming; basic mechanics of chip formation, friction, surface damage and finish; temperatures and temperature distribution during cutting; wear and tool-work compatability. Analysis of experimental data; critical review of pertinent literature and special topic assignments. 1 unit. Prerequisite: Undergraduate course in principles of metal cutting and heat treatment of metals or physical metallurgy. TRIGGER.

452. **Deformation and Mechanical Processing of Metals.** Theoretical and experimental aspects of deformation and mechanical processing of metals. Plastic deformation; fracture and fatigue; impact stresses and stress waves in metals; thermal and residual stresses; plastic forming of metals and its influence on the properties. 1 unit. Prerequisite: Mechanical Engineering 451; Metallurgical Engineering 408. TRIGGER.

458. **Laboratory Investigations in Production.** Special investigations in field of production, particularly in materials processing, metal cutting, and production engineering. ½ to 1½ units. TRIGGER, VON TURKOVICH.

493. **Seminar.** Presentation and discussion of significant developments in mechanical engineering. No credit. KONZO.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Thermodynamics.** Basic considerations of the three laws of thermodynamics; elementary statistical principles for the prediction of properties of pure substances and mixtures; transport properties; electric and magnetic systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or equivalent; consent of instructor. JACKSON, SOO.

302. **Nuclear Power Engineering.** Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptation and economics. ¾ or 1 unit. Prerequisite: Consent of instructor. JONES.

304. **Direct Energy Conversion.** Direct conversion of chemical, nuclear, and solar energies into electricity by electrochemical, thermionic, thermoelectric, photoelectric, photochemical, ferroelectric, magnetohydrodynamic, and plasma systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor; Mathematics 345. SOO.

305. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or consent of instructor. ADDY, CHOW, WHITE.

306. **Industrial Heat Transfer.** Theory and application of numerical, analogical, and experimental methods to selected heat transfer problems; application of principles of convection, condensation, and boiling heat transfer to design of heat exchange equipment. 1 unit. Prerequisite: Undergraduate courses in fluid mechanics and heat transfer. CLAUSING, HERING, SAVAGE.

309. **Experimental Gas Dynamics.** Experimental investigation of problems in the field of compressible fluid flow within enclosed channels. 1 unit. Prerequisite: Mechanical Engineering 305 or consent of instructor. ADDY, CHOW, WHITE.

311. **Instrumentation and Measurements.** Same as Agricultural Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics

of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science. STROUT.

312. **Theory of Controls.** Introduction to the theory of controls. Dynamical analysis of physical systems; steady-state operations; graphical and analytical methods of analysis; applications. ¾ or 1 unit. Prerequisite: Consent of instructor. VON TURKOVICH.

314. **Lubrication.** The theoretical basis of lubrication; hydrodynamic bearing theory; properties of lubricants; methods of testing; lubrication methods and appliances; study of the lubrication requirements of machines of many kinds. ¾ or 1 unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. ADKINS, OFFNER, RADZIMOVSKY.

332. **Theory of Internal Combustion Engines.** Analysis of reciprocating engine cycle including thermodynamics and combustion and taking into consideration effects of fuel-air mixture, variable specific heats, chemical equilibrium and dissociation, and heat losses; flow through manifolds and valves; factors effecting breathing and scavenging; supercharging; bearings, lubrication, and function; effects of variables on performance. ¾ or 1 unit. Prerequisite: Undergraduate course in internal combustion engines or consent of instructor. HULL.

341. **Engineering Analysis and Design.** Correlation of previously acquired design experience with the creative problems of synthesis and analysis that depend upon design judgment. ¾ or 1 unit. Prerequisite: Mechanical Engineering 271 or consent of instructor. BAYNE, BROGHAMER, WHISENAND.

342. **Kinematic Analysis and Synthesis.** Geometry of constrained motion; application of mathematical and other techniques to the kinematic analysis and synthesis of mechanisms. ¾ or 1 unit. Prerequisite: Undergraduate course in kinematics or consent of instructor. BROGHAMER.

343. **Dynamics of Machinery.** A course complementary to the undergraduate course with emphasis on the analytical approach to the study of dynamic forces in machines, balancing, critical speeds, shaft vibrations, governors, and gyroscopes. ¾ or 1 unit. Prerequisite: Mechanical Engineering 221 or consent of instructor.

388. **Machine Tool Systems Analysis.** A study of the components, their analysis and synthesis in machine tool systems; power components, precision motion, dynamic response of machine skeleton, linear and nonlinear conditions, control elements, and computer control of machines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186, 271, or consent of instructor. VON TURKOVICH.

Industrial Engineering

COURSES FOR GRADUATES

401. **Scientific Management, I.** Same as Industrial Administration 401. A study of modern management principles on the basis of quantitative methods, concentrating on such operation research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor. ZIMMERMAN.

402. **Scientific Management, II.** Same as Industrial Administration 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of operation research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Industrial Administration

or Industrial Engineering 401; background in computer technology or consent of instructor. ZIMMERMAN.

416. Design of Construction and Industrial Operation, I. Same as Civil Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor.

417. Design of Construction and Industrial Operations, II. Same as Civil Engineering 417. Continuation of Industrial Engineering 416. 1 unit. Prerequisite: Industrial Engineering or Civil Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

453. Work Measurement. A study of special problems of line balance, interference, and automation work loads as required to establish work standards (or production standards). 1 unit. Prerequisite: Industrial Engineering 332. PIGAGE.

454. Production Engineering. Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

458. Laboratory Investigations in Industrial Engineering. Special investigations of such problems as optimization of operations, programming systems, work standards, plant layout, and flow of materials. ½ to 1½ units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. Principles of Ergonomics. Same as Physiology 304. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. 1 unit. Prerequisite: Consent of instructor.

305. Quantitative Methods in Ergonomics. Same as Physiology 305. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. 1 unit. Prerequisite: Physiology or Industrial Engineering 304.

332. Standard Time Systems. The study of development, uses, and limitations of standard time data and predetermined time system. ¾ or 1 unit. Prerequisite: Industrial Engineering 232. PIGAGE.

333. Engineering Applications of Statistics. Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. ¾ or 1 unit. Prerequisite: Mathematics 263 or 363. HENRY.

334. Introduction to Reliability Engineering. Same as General Engineering 334. An introduction to concepts in engineering design, testing, and management for highly reliable components and systems. ¾ or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor. HENRY.

350. Manufacturing Process and Tool Design. A study of and exercises in the design of manufacturing processes and tools for maximum efficiency; the utilization of computer techniques in design of manufacturing processes and tools. ¾ or 1 unit. Prerequisite: Industrial Engineering 282 or a course in engineering economy. DOYLE.

355. **Numerical Control of Manufacturing Processes.** A study of numerical control systems, manufacturing processes, principles and practices basic to numerical control, and programming methodology for numerical control. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186 or consent of instructor; background in computer technology. Doyle.

357. **Safety Engineering.** The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. ¾ or 1 unit. Harper.

358. **Problems in Safety Engineering.** Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. ¾ or 1 unit. Prerequisite: Industrial Engineering 357; consent of instructor. Harper.

359. **Industrial Fire Protection.** Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. ¾ or 1 unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. Harper.

386. **Industrial Engineering Analysis.** Analysis and development of analytical techniques for the solution of problems in industrial engineering; application of statistical methods to uncertainty problems; analysis of linear programming techniques appropriate to the solution of allocation problems dealing with materials, money, men, and machines; queueing theories applied to maintenance and inventories. ¾ or 1 unit. Prerequisite: Mathematics 263, Industrial Engineering 286, or consent of instructor. Zimmerman.

MICROBIOLOGY

See descriptions and course listings under Life Sciences, page 241.

MINING, METALLURGY, AND PETROLEUM ENGINEERING

The Department of Mining, Metallurgy, and Petroleum Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy. The prerequisite for graduate work in metallurgical or mining engineering is the equivalent of the undergraduate courses in either of these majors which are required for the Bachelor of Science at the University of Illinois. For these major fields a Bachelor of Science in some related field may also be acceptable.

Those wishing to specialize in petroleum engineering or in the more general area of petrophysics should have a Bachelor of Science in engineering with advanced courses in mathematics, chemistry, physics, and/or geology.

A candidate for the Master of Science is required to have a minimum of eight units of graduate work, including a thesis. If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. The thesis requirement is not waived for research assistants.

Students desiring to work for the Doctor of Philosophy are required to pass the departmental qualifying examination. This examination must be taken no later than

the end of the first semester after receiving the Master of Science from this department, or not later than the end of the second semester in residence, if the student has a Master of Science from some other department or university.

The minor requirement of the Graduate College for the Doctor of Philosophy may be satisfied by taking courses in fields such as ceramics, chemistry, geology, mathematics, theorctical and applied mechanics, nuclear engineering, and physics.

GRADUATE FACULTY

Professors: C. A. Wert (Head of Department), P. A. Beck, H. K. Birnbaum, R. W. Bohl, W. H. Bruckner, A. J. de Witte, E. J. Eckel, J. J. Gilman, D. S. Lieberman, M. Metzger, B. G. Ricketts, H. E. Risser, W. D. Rose, T. J. Rowland, A. E. Scheidegger, R. M. Thomson, C. M. Wayman, F. D. Wright.

Associate Professor: C. J. Altstetter.

Mining Engineering

COURSES FOR GRADUATES

401. Advanced Mineral Dressing and Coal Preparation. Advanced theory and practice of mineral dressing and coal preparation processes. 1 unit.

402. Mine Valuation, Taxation, and Mineral Economics. A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. 1 unit.

403. Advanced Mine Administration. Current methods and systems of mine administration in use by major mining corporations. 1 unit.

405. Advanced Mine Ventilation. Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. 1 unit. Prerequisite: Consent of instructor.

406. Design of Underground Openings. Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. 1 unit. Prerequisite: Mining Engineering 356.

414. Physical Chemistry of Clays and Soils. Same as Agronomy and Ceramic Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor.

497. Special Problems. Individual studies in areas of mining or petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. 0 to 2 units. Prerequisite: Consent of instructor.

499. Thesis Research. Individual research in some phase of the general field of mining or petroleum engineering under the supervision of a member of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Mineral Processing. Crushing, grinding, flotation, proximatc analysis of coal, pumping of fluid-solid mixtures, quality control in orc dressing. ¾ unit.

302. World Mineral Economics. The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out

of their unequal geographic distribution and divided political control. ¾ or 1 unit.

351. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor.

353. **Sampling, Exploration, Valuation.** Theory of sampling applied to mineral deposits and concentrating plants; geological principles of exploration; surface and subsurface exploration; valuation. ¾ or 1 unit. Prerequisite: Geology 101 and 130; Mathematics 263.

356. **Rock Mechanics.** Mechanical properties of rocks; design of mine openings in bedded, massive, and fractured rock; methods of support; drilling; blasting. ¾ or 1 unit. Prerequisite: Mining Engineering 351.

360. **Analysis and Design of the Mining System.** Analyses of unit operation cycles and production methods; design of materials handling systems and applications of operations research. 1 unit. Prerequisite: Mathematics 263; credit or registration in Mining Engineering 356.

393. **Special Problems.** Individual studies of any phase of mining or petroleum engineering selected by the student and approved by his adviser and the staff member who will supervise the study. 0 to 1 unit. Prerequisite: Consent of instructor.

Metallurgical Engineering

COURSES FOR GRADUATES

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. 1 unit. Prerequisite: Metallurgical Engineering 405, or Physics 385, or consent of instructor.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. 1 unit. Prerequisite: Consent of instructor.

408. **Dislocations and Mechanical Properties of Metals.** General static and dynamic properties of single dislocations in crystals; dislocation interactions; properties of dislocation arrays; role of dislocations in metallurgical phenomena with particular emphasis on mechanical properties. 1 unit. Prerequisite: Consent of instructor.

409. **Crystal Physics.** The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction and diffusion, thermoelectricity, deformation, elasticity, and martensitic transformations. The effects of crystal symmetry and the properties of aggregates are discussed. 1 unit. Prerequisite: Vector algebra, determinants, and thermodynamics; consent of instructor.

410. **Advanced X-Ray Metallography.** X-ray diffraction as applied to the study of metals and alloys; effects of cold work, annealing, substructures, preferred orientation and ordering, principles of electron and neutron diffraction. 1 unit. Prerequisite: Chemistry 427 or consent of instructor.

420. **Metallurgical Thermodynamics.** Fundamental thermodynamic considerations and applications of thermodynamics to metallurgical problems; particular emphasis on heterogeneous equilibrium and thermodynamic properties of solutions; topics approached from the viewpoints of both macroscopic thermodynamics and statistical mechanics. 1 unit. Prerequisite: Metallurgical Engineering 314 or equivalent.

421. **Kinetics of Phase Changes in Metals.** The viewpoint of statistical thermodynamics, rate theory, diffusion in solids, interface energy, nucleation theories, phenomenological analysis of nucleation and growth; application to crystal growth, diffusionless phase changes, oxidation, pearlite reaction, precipitation, sintering. 1 unit. Prerequisite: Metallurgical Engineering 420 or consent of instructor.

485. **Metallurgical Engineering Problems.** Individual study in areas of metallurgical engineering not covered by regular course offerings, carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: Consent of instructor.

486. **Laboratory Investigations in Metallurgy.** Special investigations in metallurgy to provide an opportunity to employ some advanced experimental methods of research. Available only to non-thesis students enrolled in a Master of Science program. ¼ or ½ unit. Prerequisite: Consent of instructor.

493. **Seminar in Anelasticity.** Lectures and discussions of the nature of anelasticity and its application to metallurgy. 0 or ¼ unit. Prerequisite: Consent of instructor.

494. **Seminar on Phase Transformations in Metals.** Discussion of current research in this field including presentation by graduate students of their own work. 0 or ¼ unit. Prerequisite: Consent of instructor.

495. **Seminar on Diffusion and Imperfections.** Lectures and discussions on diffusion and imperfections in crystalline solids. 0 or ¼ unit. Prerequisite: Consent of instructor.

497. **Seminar on Alloy Phases.** Discussion and lectures on current research, including work by the graduate students, relating to the electronic structure and crystal structure of alloy phases. 0 or ¼ unit. Prerequisite: Consent of instructor.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical research in other laboratories by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. No credit.

499. **Thesis Research.** Individual research in specialized problems under the supervision of members of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Metallurgy of Welding.** Heat flow and thermal cycles in welding and cutting of metals; physical metallurgy and mechanical properties of weld metal and thermally altered base metal; joining methods in relation to composition, microstructure, and mechanical properties; specifications, economics, and service requirements. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 or equivalent.

302. **Powder Metallurgy.** Production and testing of powdered metals; fabrication and application of metal shapes produced from powdered metals. ½ or ¾ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304.

304. **Powder Metallurgy Laboratory.** Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302.

306. **Design of Engineering Alloys.** A study of the fundamental principles which determine the constitution, structure, treatment, and application of alloy steels and other special-purpose high-performance alloys. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 and 311.

307. **Corrosion of Metals.** Electrochemistry, thermodynamics, and kinetics of corrosion; behavior of ferrous and nonferrous metals; corrosion rates; corrosion control,

cathodic and anodic protection; high-temperature corrosion; corrosion testing; electrolytic machining methods. ¾ or 1 unit. Prerequisite: Mechanical Engineering 234 or equivalent.

310. **X-Ray Metallography.** X-ray generation and scattering with applications to problems in physical metallurgy, such as phase identification, the determination of solid solubility, the measurement of grain size and preferred orientation, and other topics. ¾ unit. Prerequisite: Physics 108.

311. **Advanced Phase Diagrams.** Interpretation of multicomponent phase diagrams for metal systems. ½ unit. Prerequisite: Metallurgical Engineering 201 or equivalent.

314. **Metallurgical Thermodynamics.** Thermodynamic principles are applied to the study of phase and chemical equilibrium and to the calculation of free energy of phases. ¾ unit. Prerequisite: Credit or registration in Chemistry 246.

315. **Metallurgical Kinetics.** Diffusion and heat flow calculations and their applications to kinetics of metallurgical processes. ¾ unit. Prerequisite: Metallurgical Engineering 208 and 314.

316. **Mechanical Metallurgy.** Fundamentals of plastic deformation of crystalline solids; elementary theory of statics and dynamics of dislocations; applications to deformation of single crystals and polycrystals; fracture; effect of metallurgical variables on mechanical properties. ¾ unit. Prerequisite: Consent of instructor.

318. **Physics of Metals.** The nature of the perfect and imperfect crystal, the electronic structure of solids, electrical conduction in metals and semiconductors, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Consent of instructor.

384. **Properties of Solids.** Perfect and imperfect crystal lattices, electronic structure of solids including basic theory and applications to transport properties of metals and semi-conductors, semi-conductor diodes; dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

385. **Structural Physical Metallurgy.** A comprehensive survey of selected areas of structural physical metallurgy, excluding electronic processes. Not open to graduate students with an undergraduate major in metallurgy. ¾ unit. Prerequisite: Physical chemistry or classical thermodynamics; differential equations. Prerequisite: Consent of instructor.

Petroleum Engineering

COURSES FOR GRADUATES

420. **Porous Media Hydromechanics.** Introduction to theoretical hydromechanics. Classification of fluids, fundamental laws and basic equations of motion applicable to microscopic and macroscopic regimes; treatment of interfacial forces and surfaces in multi-phase flow as particularly applied to porous media systems. ¾ or 1 unit. Prerequisite: Mathematics 343, Petroleum Engineering 373, or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

371. **Reservoir Mechanics, I.** The mechanics of the movement of fluids in the porous rock reservoirs of the subsurface, especially as related to questions dealing with the production and storage of petroleum fluids, ground water, and natural gases. 1 unit. Prerequisite: Mathematics 345; Theoretical and Applied Mechanics 235.

372. **Reservoir Mechanics, II.** A continuation of Petroleum Engineering 371, showing the application of the fundamental concepts in developing procedures for fore-

casting the future performance of reservoir systems as derived from a knowledge of initial and boundary conditions, and as derived with reference to the past history of fluid movement and displacement. 1 unit. Prerequisite: Petroleum Engineering 371.

373. **Advanced Reservoir Engineering.** Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. ¾ or 1 unit. Prerequisite: Mathematics 345, Petroleum Engineering 372, or consent of instructor.

MUSIC

The School of Music offers the Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Master of Music. The major field may be in musicology, music theory and composition, or performance and literature (organ, voice, piano, violin, viola, cello, solo wind instruments, and percussion instruments).

The admission requirement, in terms of grade-point average, is at least 3.5. In addition, an applicant is required: (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or its equivalent, at the University of Illinois or another accredited institution; and (2) to pass a qualifying examination in the major field of concentration. If the major is to be performance and literature, this examination is essentially one of performance on the major instrument. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of German or French is required. Candidates in voice should have had one year each of French, German, and Italian, unless two years of one language have been completed in high school. All prospective candidates for the Master of Music must take a placement examination in the history of music and the theory of music.

Doctor of Musical Arts. The fields of specialization for this degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree programs comprise the following major areas: composition, choral music, piano, organ, violin, viola, cello, voice, and wind instruments.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. The prerequisites for admission are as follows:

(1) The Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units: theory, two units; Music 428, Problems and Methods, one unit; electives, three units.

(b) Major in Performance and Literature: performance and literature, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) A high level of proficiency in composition or performance.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature,

psychology, and philosophy. Students lacking an appropriate background in liberal arts and sciences may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination.

(5) Successful completion of entrance examinations. These examinations in performance and literature, the history of music, and the theory of music must be taken immediately prior to the student's first registration. Prospective applicants should write to the School of Music, 100 Smith Music Hall, for complete information concerning the nature of these examinations.

If the candidate fails to pass the entrance examinations, he must repeat and pass all or parts of them no later than the end of the second semester in residence, or pass deficiency courses with grades of at least B. Until the examinations or courses have been passed, the student is considered to have a provisional status.

After admission to the doctoral program the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, calendar, grades, and major and minor fields.

A minimum of sixteen units of graduate credit beyond the eight units required for the Master of Music is necessary to earn the Doctor of Musical Arts. In the fields of composition, and performance and literature, three units are devoted to the completion of a special doctoral project: for the former, the writing of an original score on a large scale; for the latter, the study of a comprehensive repertory and either two solo recitals, or one solo recital and two of the following options: (1) a concerto performance; (2) the performance of a major role in an opera or oratorio; (3) a chamber music program; (4) a lecture recital; (5) a coaching performance of an instrumental or vocal ensemble. Two units are devoted to the completion of an original thesis. In the field of choral music, one unit is devoted to a doctoral project involving the preparation and presentation of a choral program of approximately one hour in length selected from a comprehensiae repertory. Four units are devoted to the completion of an original thesis.

In addition to the foregoing, the work includes the following required courses: composition or performance and literature, three units; Music 420, Seminar in Music Literature for Doctoral Candidates, two units. One unit of work must be taken in the field of education or music education unless the candidate has previously passed equivalent course work. At least two, but no more than four, units are devoted to an outside minor field.

Three of the six units of electives must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College.

Doctor of Philosophy in Musicology. The Doctor of Philosophy in Musicology is intended for applicants whose interests lie in research in the history of music, theory of music, psychology of music, ethnomusicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see pages 18 to 22), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the Master of Music with a major in musicology or theory of music; (2) have acquired a background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the sixteen units must be in Music 499 and are devoted to the completion

of an original doctoral thesis. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or the equivalent, in courses including Music 320, 322, 414, 415, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in performance.

(2) A minimum of two units in one or two minor fields.

(3) In addition to the general foreign language requirements of the Graduate College, proficiency in Latin is expected. An examination in one or more additional foreign languages may be required when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(4) A preliminary examination administered by a committee appointed by the Dean of the Graduate College.

Master of Science in Music Education. Candidates for this degree must earn four units in music, two units in education, and two units in electives. Requirements are four units of music; two courses from History and Philosophy of Education 301, 302, 303, 304, one unit; Educational Psychology 311 and 312, one unit; and electives, two units. The electives may be in music, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy placement examinations in music history, music theory, and performance and literature in the principal music area. See pages 41 and 42.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music history, music theory, and applied music.

Residence. At least four units must be earned in residence on the Urbana campus. This requirement may be met by spending one full semester or two eight-week summer sessions in residence.

Program. A minimum of eight units beyond the master's degree is required. Music 440 and 441 and either Educational Psychology 411 or 412 are required. The remainder of the program is based upon the student's needs and interest and upon the deficiencies revealed in placement tests. No more than one unit of performance and literature may be counted toward the certificate.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Doctor of Education. The program leading to the Doctor of Education with a major in music education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations are administered by the School of Music in music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. At least sixteen units of work beyond the master's degree are required, including six units in music courses and six units in education courses. No more than two units of credit in applied music may be counted toward the degree.

The following courses are required: History and Philosophy of Education 410, Educational Psychology 415, Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. For work completed elsewhere, see page 38. Extramural course work may not be included as part of this sixteen-unit requirement.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

GRADUATE FACULTY

Professors: D. A. Branigan (Director of School of Music), B. Bergethon, G. W. Binkerd, Dorothy E. Bowen, H. A. Decker, P. S. Farrell, S. Fletcher, B. R. Foote, J. C. Garvey, S. Goldthwaite, B. M. Goodman, C. E. Hamm, L. A. Hiller, M. H. Hindsley, G. H. Hunter, K. Kellogg, J. R. Kelly, H. Kessler, Colleen J. Kirk, E. D. Kisinger, C. Leonhard, A. J. McDowell, P. S. Pettinga, Claire L. Richards, A. L. Ringer, P. Rolland, H. C. Schmitt, H. O. Sexton, S. Stravinsky, R. H. Swenson, P. Ulanowsky, Grace E. Wilson, L. E. Zirner.

Associate Professors: J. L. Bailey, E. S. Berry, A. M. Carter, Dorothy E. Clark, W. R. Coggins, R. J. Colwell, C. O. DeLaney, B. E. Edlefsen, L. T. Fredrickson, K. L. Gaburo, R. E. Gray, R. J. Hamilton, T. L. Holden, B. B. Johnston, H. Karp, C. J. Kleinsteuber, E. J. Krolick, J. H. McKenzie, W. H. Miller, B. Nettl, P. Painter, D. W. Sanders, R. B. Smith, R. E. Thomas.

Assistant Professors: Mary M. Burdette, A. Hughes, R. B. MacDonald, S. J. Martirano, Evelyn Reynolds.

Instructors: S. H. Hansell, Jane E. Schleicher, A. R. Thomas.

COURSES FOR GRADUATES

400. Advanced Instrumentation: Chamber and Symphonic. Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. Advanced Instrumentation: Band. Arrange for the concert band, works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. Analysis in Relation to Performance and Interpretation, I. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the

Renaissance to the present day with emphasis on the smaller forms. 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. LEONHARD.

403. **Analysis in Relation to Performance and Interpretation, II.** A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. 1 unit. Prerequisite: Music 402. LEONHARD.

406. **Composition.** Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. ½ to 1½ units. COMPOSITION FACULTY.

410. **History of Music Theory.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in musicology or composition, or consent of instructor. HUGHES.

411. **Introduction to Ethnomusicology.** A comprehensive survey of concepts, problems, and methods of research in non-Western and folk music. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. NETTL.

412. **History of Musical Aesthetics, I.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles. From Pythagoreanism to the humanistic period. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Graduate standing in music. RINGER.

413. **History of Musical Aesthetics, II.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles from the seventeenth century to the present day. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 412. RINGER.

414. **Notation, I.** The history of notation from its beginning to 1400. ½ unit. Prerequisite: Consent of instructor. GOLDTHWAITE.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. ½ unit. Prerequisite: Music 414 or consent of instructor. GOLDTHWAITE.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 312 or consent of instructor. HUGHES.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 416 or consent of instructor. HUGHES.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory, and aesthetics of opera. The principal composers covered are Monteverdi, Cavilli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. ½ or 1 unit. Prerequisite: Music 312 or consent of instructor. HAMM.

419. **The History of Opera from Mozart to the Present.** A detailed examination of stylistic and structural developments in opera after Gluck, witn special reference to representative works from Mozart to Schoenberg viewed in relation to the general musical and cultural background of their time and place of origin. ½ or 1 unit. Prerequisite: Music 312 and 313, or consent of instructor. HAMM.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students (except those in choral music) enrolled in the Doctor of Musical Arts program. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. **Seminar in Music Education.** An introduction to problems and methods of research in music education. Required of all candidates for the Doctor of Education in music education. 1 unit. Prerequisite: Graduate standing in music education or consent of instructor. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. ½ or 1 unit. Prerequisite: Graduate standing in music theory or consent of instructor.

423. **Seminar in Musicology.** Problems in historical and systematic musicology; discussions of special problems and reports on individual research. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. HAMM, RINGER.

424. **Bach, I.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music.

425. **Bach, II.** The life and times of Johann Sebastian Bach, with a critical and analytical study of selected groups of representative works from all fields of his creative activity. ½ or 1 unit. Prerequisite: Representative theory and history courses required for the Bachelor of Music.

426. **Beethoven, I.** ½ or 1 unit. Offered in 1967-1968 and in alternate years.

427. **Beethoven, II.** ½ or 1 unit. Offered in 1967-1968 and in alternate years.

428. **Problems and Methods.** An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports of bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. 1 unit. HANSELL.

429. **Historical Studies in Twentieth-Century Music.** A seminar in contemporary music, with emphasis on the historical foundations of current trends in musical composition. ½ to 1 unit; maximum accumulated credit, 2 units. Prerequisite: Music 315, 422, or equivalent. HILLER.

430. **Advanced Orchestra Conducting and Literature.** Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestras. 1 unit. Prerequisite: Previous conducting experience. GOODMAN.

431. **Advanced Band Conducting and Literature.** Study of problems and techniques of band conducting and a survey of literature for the concert band. 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Techniques.** An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. **Advanced Choral Literature and Conducting.** An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. 1 unit. Prerequisite: Graduate standing in music education, Music 432 or equivalent, or consent of instructor. DECKER, KIRK.

434. **Piano Literature.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. KELLOGG.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. PETTINGA.

437. **String Instrument Literature.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. FARRELL.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. EDLEFSEN, KISINGER.

439. **Percussion Instruments Literature.** An integrating course offering the opportunity to survey and analyze the field of solo and ensemble percussion literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in music; consent of instructor. MCKENZIE.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. ½ or 1 unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

444. **The General Music Program in Elementary Schools.** A detailed consideration of elementary general music, its objectives, organization, operation. Special attention is given to materials and methods of teaching. ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. **Seminar and Laboratory in Musical Acoustics, I.** Special topics in acoustics, including formant theory and communication theory; application of electrical and electronic techniques to music reproduction and propagation; audio-visual aids.

½ or 1 unit. Prerequisite: Graduate standing in music or music education, or consent of instructor. HILLER.

447. **Seminar and Laboratory in Musical Acoustics, II.** Techniques of modern experimental electronic music; related music theory; computational music and related topics. Individual projects for selected students. ½ or 1 unit. Prerequisite: Music 446 or consent of instructor. HILLER.

450. **History of Vocal Ensemble and Choral Music, I.** A critical and analytic study of vocal and choral ensemble music from the Middle Ages to 1750. 1 unit; S, ½ unit. HANSELL.

451. **History of Vocal Ensemble and Choral Music, II.** A critical and analytic study of vocal and choral ensemble music from 1750 to the present. 1 unit; S, ½ unit. HUGHES.

480. **Piano.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

481. **Voice.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

482. **Organ.** Selected studies from the masterworks of organ literature. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

483. **String Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

484. **Wind Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

485. **Percussion Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

489. **Doctoral Projects.** Special projects for candidates for the Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. 1 to 3 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

499. **Thesis Research.** Research in special projects. 0 to 4 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Eighteenth-Century Counterpoint.** The study of the technique of contrapuntal writing as found in the works of J. S. Bach and other eighteenth-century composers. Imitation, canon, invertible counterpoint, two- and three-part inventions, etc., are studied through writing and analysis of compositions by eighteenth-century composers. ½ unit. Prerequisite: Music 104 and/or consent of instructor. BINKERD, FREDRICKSON, GABURO, KELLY.

301. **Fugue.** The study of fugal writing during the eighteenth and early nineteenth centuries. A continuation of the study of tonal counterpoint begun in Music 300, with special emphasis on the study and analysis of the fugal works of J. S. Bach, Handel, and Beethoven and on the writing of fugues and part fugues. ½ unit. Prerequisite: Music 300 and/or consent of instructor. BINKERD, FREDRICKSON, GABURO, KELLY.

302. **Musical Acoustics, I.** A survey of basic topics in the physics of music: wave motion and the physical properties of sound; the ear and hearing; timbre, formant theory,

and the acoustical properties of musical instruments. ½ unit. Prerequisite: Consent of instructor. HILLER.

303. **Musical Acoustics, II.** Acoustics, mathematics, aesthetics of pitch organization in music; scales, tuning, and temperament; pitch and rhythm, and their structural interrelationships; theories of perception of pitch and rhythm. ½ unit. Prerequisite: Music 302 and/or consent of instructor. JOHNSTON.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used and includes the study of form and harmony as these bear on the problems. ½ unit. Prerequisite: Music 104 or consent of instructor.

305. **Analytical Techniques, II.** Continuation of Music 304, beginning with the early seventeenth century and coming down to the present day. ½ unit. Prerequisite: Music 304 or consent of instructor.

306. **Composition.** Work in original composition including the small and large homophonic forms. ½ or 1 unit. Prerequisite: Music 104 or 106, or consent of instructor. COMPOSITION FACULTY.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. ½ unit. Prerequisite: Consent of instructor. BINKERD.

308. **Analysis of Musical Form.** An intensive study of representative compositions of the sixteenth through the twentieth centuries for structure and form. ½ unit. Prerequisite: Music 104 and 109, or consent of instructor. FARRELL.

309. **Seminar in Music for Dance.** Theory and practice of combining sound and movement in theatrical dance. Individual projects providing experience in collaboration for both composers and choreographers. ½ unit. Prerequisite: Music 106, 306, or Dance 265 and/or consent of instructor. A. R. THOMAS.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HUGHES.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HUGHES.

312. **Music of the Baroque and Classical Period.** A history of music from about 1600 to 1800. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HANSELL.

313. **Music of the Nineteenth and Twentieth Centuries.** A history of music from about 1800 to the present. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. MACDONALD.

314. **History of Musical Instruments.** The evolution of instruments, both Western and non-Western, considered in their social and cultural settings; construction and playing techniques of instruments treated in relation to performance practice and stylistic developments. ½ unit. Prerequisite: Music 213 and 214, or consent of instructor. NETTL.

315. **Contemporary Music.** A survey of all important trends, forms, and styles of modern music from 1875 to the present. ½ unit. Prerequisite: Consent of instructor. HAMM.

316. **Introduction to Music of the World's Cultures.** Same as Anthropology 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. **Area Studies in Ethnomusicology.** Same as Anthropology 315. A seminar devoted to intensive study in the music of one specific culture, e.g., (a) Japan, (b) China, (c) Indonesia, (d) India, (e) the Near East, (f) African and New World Negro, (g) European and American folk cultures, (h) American Indian. ½ unit; maximum accumulated credit, 2 units. Prerequisite: Senior standing in music or consent of instructor. NETTL.

318. **History of Performance Practices, I.** The study of musical performance from about 900 to 1600. Discussion of musical instruments, makeup of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. **History of Performance Practices, II.** The study of musical performance from 1600 to 1750. Discussion of musical instruments, ornamentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. **Proseminar.** Provides special preparation in specialized fields of musicology, music education, theory, and composition. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music or music education; consent of instructor. GRADUATE FACULTY.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music, or consent of instructor. HAMM.

323. **Opera Production, I.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 265 and 381; consent of instructor. ZIRNER.

324. **Opera Production, II.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 323. ZIRNER.

330. **Applied Music Pedagogy.** A survey of techniques, practices, and materials; presentation of group and individual instruction; an approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. ½ unit; maximum accumulated credit, 1 unit. Prerequisite: Consent of instructor. LYKE, MILLER, ROLLAND, G. WILSON.

332. **Church Music Literature.** A survey of the development of church music with emphasis on the period since 1500. ½ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Music 214 or 311, or consent of instructor. HAMILTON.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. ½ unit. Prerequisite: Music 332 or consent of instructor. HAMILTON.

334. **The Music of America, I.** A study of folk, popular, and art music in America from the time of the first European settlers through the middle of the nineteenth century; psalmody, early opera and concert life, African and European folk music, the singing school, music of European immigrants, and the roots of jazz. ½ unit. Prerequisite: Senior standing in music or consent of instructor. HAMM.

335. **The Music of America, II.** A study of chamber, choral, and orchestral music written by American composers from 1850 to the present; jazz and its offshoots; folk and popular music, and experimental music in America. ½ unit. Prerequisite: Senior standing in music or consent of instructor. Hamm.

340. **Instrumental Clinic and Band Pageantry.** A study of the peculiarities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing, charting and show continuity, marching fundamentals, and special problems. ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. Kisinger.

341. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. Kisinger.

342. **Percussion Methods.** Designed primarliy for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. ½ unit. Prerequisite: Senior or graduate standing in music education; Music 174 and 257, or equivalent. McKenzie.

344. **Methods of String Class Teaching.** Designed primarily for eachers of school music who are not performers on a string instrument, yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Senior or graduate standing in music education or consent of instructor.

345. **Teaching Techniques of Music Theory.** Teaching materials, methods, texts, and pedagogical sequence are discussed and analyzed, including an intensive survey of the structural materials normally covered during the first two years of collegiate study. ½ unit. Prerequisite: Music 300 or consent of instructor. Carter.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music education or consent of instructor. Bergethon, Leonhard, R. E. Thomas.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1968 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. McDowell, Woodwind Faculty.

348. **Teaching of Brass Instruments.** Designed primarliy for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1967 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. Sexton, Brass Faculty.

349. **Music in Early Childhood.** A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. ½ unit. Prerequisite: Senior or graduate standing in music education or child development. Smith.

350. **Advanced Ensemble Music.** Selected projects in the study and performance of ensemble literature including the areas of operatic, instrumental, and vocal-choral literature and accompanying. ½ unit; S; ¼ unit. Prerequisite: Registration in applied music at the 300 level; consent of instructor. Garvey, Hunter, Swenson, Zirner.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

377. Class Piano (Advanced). An integrated course in piano instruction with emphasis placed upon the acquisition of keyboard knowledges and skills essential for effective school music teaching; includes work in harmonization, transposition, improvisation, and vocal and instrumental score reduction. ½ unit. Prerequisite: Music 104, 109, 180, or consent of instructor. LYKE.

380. Piano. ½ or 1 unit; S, ¼ or ½ unit. BILSON, FLETCHER, KARP, RICHARDS, SANDERS, STRAVINSKY.

381. Voice. ½ or 1 unit; S, ¼ or ½ unit. BAILEY, BOWEN, BURDETTE, CLARK, FOOTE, KELLOGG, MILLER, REYNOLDS, SCHLEICHER, G. WILSON.

382. Organ. ½ or 1 unit; S, ¼ or ½ unit. HAMILTON, PETTINGA.

383. Violin. ½ or 1 unit; S, ¼ or ½ unit. ROLLAND, SCHMITT.

384. Viola. ½ or 1 unit; S, ¼ or ½ unit. GARVEY.

385. Cello. ½ or 1 unit; S, ¼ or ½ unit. FARRELL, SWENSON.

386. String Bass. ½ or 1 unit; S, ¼ or ½ unit. KROLICK.

387. Flute. ½ or 1 unit; S, ¼ or ½ unit. DELANEY.

388. Clarinet. ½ or 1 unit; S, ¼ or ½ unit. COGGINS, MCDOWELL.

389. Oboe. ½ or 1 unit; S, ¼ or ½ unit. EDLEFSEN.

390. Bassoon. ½ or 1 unit; S, ¼ or ½ unit. BERRY.

391. Cornet and Trumpet. ½ or 1 unit; S, ¼ or ½ unit. SEXTON.

392. French Horn. ½ or 1 unit; S, ¼ or ½ unit. HOLDEN.

393. Trombone. ½ or 1 unit; S, ¼ or ½ unit. GRAY.

394. Baritone. ½ or 1 unit; S, ¼ or ½ unit. NUTAITIS.

395. Tuba. ½ or 1 unit; S, ¼ or ½ unit. NUTAITIS.

396. Percussion. ½ or 1 unit; S, ¼ or ½ unit. MCKENZIE.

397. Harp. ½ or 1 unit; S, ¼ or ½ unit. KLEINSTEUBER.

398. Saxophone. ½ or 1 unit; S, ¼ or ½ unit. COGGINS.

399. Harpsichord. ½ or 1 unit; S, ¼ or ½ unit. HUNTER.

NUCLEAR ENGINEERING

Nuclear engineering offers work leading to the Master of Science and Doctor of Philosophy and provides courses and research facilities for doctoral candidates in nuclear engineering and related fields.

The programs in nuclear engineering are open to all graduates in engineering, mathematics, and the physical sciences who have a grade-point average of at least 4.0 out of 5.0 for the last two years of undergraduate work. Students with grade-point averges below 4.0 but above 3.5 are considered individually. Applicants who fall in this latter category are invited to support their applications with a letter explaining the circumstances. It is recommended that they also submit letters of reference and information as to their rank in class.

Undergraduate courses in differential equations, advanced calculus, atomic physics, and nuclear physics are required as background for the nuclear engineering program. A student may be admitted before he has completed these four prerequisites, but he must then allow an additional semester or summer of study for completion of the master's degree.

The general requirements of the Graduate College must be met for either degree. Specific requirements for the degrees in nuclear engineering are as follows:

(1) The master's degree requires eight units including a thesis, or nine units without a thesis. At least four of these units must be in nuclear engineering courses. The remaining courses are electives which must be approved by the candidate's adviser.

(2) Excluding the thesis requirement, a candidate for the doctor's degree must complete a minimum of sixteen units of graduate work. Six of these units must be in nuclear engineering. An integrated group of at least four units of graduate courses in an established engineering discipline or in one of the physical sciences is strongly recommended.

A two-megawatt TRIGA Mark II reactor is located on campus for research and teaching in nuclear engineering. The reactor can be pulsed to power levels of 1,000 megawatts for special studies. Teaching facilities include a nuclear metallurgy laboratory, a radiochemistry and nuclear instrumentation laboratory, a boiling water heat transfer loop, several subcritical natural uranium assemblies, a waste disposal laboratory, a shielding laboratory, and a direct energy conversion laboratory.

For further information, see the brochure *Graduate Program in Nuclear Engineering*, available from the Nuclear Engineering Office, 216 Nuclear Engineering Laboratory.

GRADUATE FACULTY

Professors: M. E. Wyman (Chairman of Nuclear Engineering Program), F. T. Adler, A. W. Allen, R. W. Bohl, A. P. Boresi, B. T. Chao, A. B. Chilton, B. B. Ewing, L. Goldstein, C. D. Hendricks, J. S. Koehler, R. J. Martin, M. S. McVay, J. E. Pearson, S. L. Soo.

Associate Professors: R. A. Axford, G. A. Costello, D. F. Hang, J. P. Hummel, G. H. Miley, J. T. Verdeyen.

Assistant Professors: J. H. Austin, O. L. Gaddy, B. G. Jones, N. H. Schilmoeller, B. H. Wehring.

COURSES FOR GRADUATES

401. Fundamentals of Nuclear Engineering. A lecture and problem course to provide background for further work in nuclear engineering. Problems in materials, heat transfer, and fluid flow. Special emphasis is given to basic ideas and the mathematical similarity of problems in heat transfer, fluid flow, and neutron diffusion. 1 unit. Prerequisite: Physics 282 or 382 and Mathematics 345, or equivalent, or consent of instructor.

411. Nuclear Reactor Heat Transfer. Selected topics in nuclear reactor heat transfer: thermal analysis of fuel elements under steady and transient operation, convective energy transport from reactor cores, two-phase flow and boiling in reactor cores, and liquid metal coolant systems. ¾ to 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

421. Nuclear Concepts. Selected topics in low-energy nuclear physics of general interest to the nuclear engineering field; nuclear reactions, cross sections, slowing down and interactions with matter, decay theory, and nuclear forces. 1 unit. Prerequisite: Physics 282 or 382; consent of instructor.

431. Nuclear Metallurgy. Metallurgical principles applied to materials problems in nuclear engineering, including topics in production of uranium, corrosion, radiation damage, fuel element fabrication, and fuel reprocessing. 1 unit. Prerequisite: Consent of instructor.

441. Nuclear Radiation Shielding. Radiation units and measurement; tolerance limits; interaction of radiation and matter; geometry factors in attenuation; gamma ray and neutron attenuation; monent theory for attenuation; application to reactors, protective shelters, and space vehicles. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

447. Radioactive Waste Disposal. Same as Civil Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous waste disposal; air monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282 or Chemistry or Nuclear Engineering 398, or consent of instructor.

451. Reactor Laboratory. Reactor operation: start-up, changes in power level, and shutdown. Reactor instrumentation: subcritical assemblies; flux measurements in core and thermal column; control rod worth measurements; effects of changes in fuel configurations; activation and neutron beam experiments. ½ or 1 unit. Prerequisite: Consent of instructor.

454. Nuclear Engineering Laboratory Investigations. Individual laboratory investigations in nuclear engineering. ½ to 1½ units. Prerequisite: Consent of instructor.

455. Reactor Physics, I. Same as Physics 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections; diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Mathematics 343 and 345, Nuclear Engineering 347, or consent of instructor.

456. Reactor Physics, II. Same as Physics 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Nuclear Engineering 455 or consent of instructor.

458. Nuclear Reactor Engineering. Development of engineering design phases of the fission chain reactor: reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. 1 unit. Prerequisite: Consent of instructor.

460. Reactor Kinetics. Discussion of special topics such as response of reactor systems to changes of power demand and reactivity. Transfer function analysis, nonlinear problems of reactor dynamics, reactor stability; fuel cycles; digital and analog computer methods for solving reactor kinetic problems. 1 unit. Prerequisite: Nuclear Engineering 401 and 455, or consent of instructor.

467. Thermomechanics of Nuclear Reactor Systems. Same as Theoretical and Applied Mechanics 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal shock and thermal stress-wave propagation; current thermomechanics problems in nuclear reactor design; term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

490. Special Topics. Selected areas are considered which are of current interest in research, such as nuclear materials, advanced reactor systems, thermonuclear problems, digital computer methods in nuclear engineering, advanced topics in reactor theory. ½ or 1 unit. Prerequisite: Consent of instructor.

495. Nuclear Engineering Problems. Individual study in areas of nuclear engineering and closely related fields not covered by regular course offerings. The work is

carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: At least three units of graduate work; consent of instructor.

497. **Seminar in Nuclear Science and Engineering:** Lectures and discussions on current work in research and development in nuclear engineering and related fields by staff, advanced students, and visiting lecturers. No credit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

347. **Introduction to Nuclear Engineering.** Nuclear particles and nuclear chain reactions, energy release from fission; classification of nuclear reactors; fast and thermal reactors; reactor theory; slowing down and diffusion of neutrons; radiation shielding; materials of construction, radiation damage; reactor instrumentation. safety, and control; chemical processing of nuclear materials. ¾ or 1 unit. Prerequisite: Physics 282 or 382 and senior standing in engineering, or consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Civil Engineering 349. Principles and practice of health physics and radiation protection enginereing, including such topics as: principles of dosimetry, sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

397. **Radiochemistry.** Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions. interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Chemistry 398. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. One laboratory and one discussion period per week. ½ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

NUTRITIONAL SCIENCES

Graduate training programs in the nutritional sciences are offered by the Departments of Animal Science, Dairy Science, Food Science, and Home Economics. Programs are available which lead to either the Master of Science or Doctor of Philosophy degree.

The degree requirements are designed to provide the basic knowledge of those disciplines (such as biochemistry, physiology, and microbiology) which is necessary for productive research in the broad field of the nutritional sciences, along with advanced training in an area of specialization. Opportunities for thesis research in the participating departments range from metabolic studies at the cellular or molecular level to applied problems pertaining to the mutrition of domestic animals and man. Information pertaining to general admission requirements is given in the departmental sections of this catalog. Inquiries should be directed to individual departments.

PHILOSOPHY

The Department of Philosophy offers work leading to the Master of Arts and Doctor of Philosophy.

Students beginning graduate work with philosophy as their major subject are

expected to have a grade-point average of at least 4.0 for the last sixty hours of work completed. Applications of students whose grade-point averages are below 4.0 but above 3.75 are considered on an individual basis, as are also all applications for entrance with advanced standing.

In addition, students applying for admission in philosophy should have had courses in logic, ethics, history of philosophy, and theory of knowledge. Students with deficiencies are required to take one or more of the following courses: Philosophy 102 (or 333), 321, 303, 306, or 330, in addition to meeting the minimum requirements of eight units for the master's degree.

Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic, philosophy of science, and philosophy of language; and theory of value, including ethics, aesthetics, social philosophy, and philosophy of religion. In addition to completing eight of units graduate work, the candidate must take an oral examination on the work represented by these units, including his master's thesis.

Doctor of Philosophy. A candidate carries on (1) major studies in one of three fields within the department; (2) minor studies amounting to at least two units in each of the two remaining fields; and (3) minor studies amounting to at least two units in a department other than philosophy. The candidate's choice of major and minors must be approved by the department.

The candidate must pass a preliminary examination, write a dissertation of publishable quality, and pass a final examination on the dissertation.

A detailed staement of the special departmental requirements for graduate students can be obtained from the Department of Philosophy, 105 Gregory Hall.

GRADUATE FACULTY

Professors: B. J. Diggs (Chairman of Department), A. H. Donagan, M. H. Fisch, A. R. Turquette, F. L. Will.

Associate Professors: C. E. Caton, H. M. Tiebout.

Assistant Professors: H. S. Chandler, R. N. Faber, R. J. Swartz, J. J. Valberg, W. J. Wainwright, J. D. Wallace.

COURSES FOR GRADUATES

401. Seminar in Ancient Philosophy. 1 unit. May be repeated for credit. Fisch.

403. Seminar in Medieval Philosophy. 1 unit. Diggs.

405. Seventeenth-Century Continental Thought (Descartes, Spinoza, Leibnitz). A study of the basic philosophical works of the three leading continental thinkers of the century. 1 unit. Donagan.

407. British Empiricism. 1 unit. Turquette.

408. German Idealism (Kant). 1 unit.

409. Recent American Philosophy. Major American philosophers and movements since about 1900. Reports and discussions. 1 unit. Fisch.

411. Seminar in Recent Ethical Theory. 1 unit; may be repeated for a maximum of 2 units. Diggs.

412. Seminar in Social Philosophy. A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. 1 unit. May be repeated for credit. Diggs.

413. Logical Theory. 1 unit. Prerequisite: A course in logic or consent of instructor. Turquette.

415. **Seminar in Metaphysics.** Intensive study of a selected topic of major importance in the field of metaphysics. 1 unit. May be repeated for credit. CATON.

417. **Seminar in the Philosophy of Science.** Various problems arising from specific studies in philosophy pertaining to science and vice versa. To be offered with varying topics. 1 unit. May be repeated for credit.

420. **Seminar in Semantics.** Same as Communications 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. CATON.

421. **Seminar in Contemporary Problems.** Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

422. **Seminar in Contemporary Problems.** Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

423. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit. WILL.

424. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit. WILL.

425. **Seminar in the Philosophy of Mind.** Selected topics from major writings in the philosophy of mind. 1 unit. May be repeated for credit.

430. **Seminar in Modern Aesthetics.** 1 unit.

439. **Seminar in the Philosophy of Mathematics.** Detailed examination of important questions arising from philosophical and logical analyses of mathematics. 1 unit. May be repeated for credit. Prerequisite: Consent of instructor.

483. **Individual Topics.** Individual study and oral written reports on topics not covered in other courses. Not more than one unit may be counted toward the A.M. degree and not more than two toward the Ph.D. degree. Topics and plan of study must be approved by the candidate's adviser and by the staff member who directs the work, ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** 1 unit. FISCH.

304. **History of Medieval Philosophy.** Lectures and reading in the history of philosophy from St. Augustine to William of Ockham. ¾ or 1 unit. Prerequisite: Philosophy 101 or 303. DIGGS.

306. **History of Modern Philosophy.** 1 unit. DONAGAN.

307. **History of Modern Philosophy.** Bacon, Hobbes, Locke, Berkeley, Hume. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

308. **History of Modern Philosophy.** Descartes, Spinoza, Leibnitz, Kant. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

309. **The Philosophy of Plato.** ¾ or 1 unit. Prerequisite: Philosophy 101 or 303.

310. **The Philosophy of Aristotle.** An intensive study of major works of Aristotle or of some aspect of his philosophy. 1 unit. Prerequisite: Philosophy 101 or 303.

311. **Philosophic Ideas of the Nineteenth and Twentieth Centuries.** ¾ or 1 unit. TIEBOUT.

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. ¾ or 1 unit. Prerequisite: One course in philosophy. Fisch.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. ¾ or 1 unit. Prerequisite: One course in philosophy.

319. **Philosophical Ideas in Latin America.** A survey of the main philosophical currents and thinkers of Latin America. ½ or 1 unit. Prerequisite: One course in philosophy.

321. **Ethics and Value Theory.** ¾ or 1 unit. Prerequisite: One course in philosophy. Caton, Diggs.

322. **Recent Developments in Ethics.** Ethical theories of the last fifty years: intuitionism, naturalism, pragmatism, emotivism, existentialism, analytic ethics. ¾ or 1 unit. Prerequisite: Philosophy 103, 105, or 321.

323. **Philosophy of Art.** A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. ¾ or 1 unit.

324. **Philosophy of Religion.** ¾ or 1 unit. Prerequisite: One course in philosophy. Wainwright.

325. **Philosophy of Mind.** Philosophical problems arising in connection with mental phenomena; the relation of mind and body; free will and determinism; our knowledge of other minds; the self and personal identity. ¾ or 1 unit. Prerequisite: One course in philosophy.

326. **Metaphysics.** ¾ or 1 unit. Prerequisite: One course in philosophy.

327. **Scientific Method.** Methodology and epistemology; empirical knowledge and learning from experience; science and common sense; scientific explanation; historical examples; generalizing and historical science; natural and social science historicism; explanation in the social sciences. ¾ or 1 unit.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. ¾ or 1 unit. Prerequisite: One course in philosophy. Turquette.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. ¾ or 1 unit. Prerequisite: One course in philosophy. Caton.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. ¾ or 1 unit. Prerequisite: One course in philosophy. Caton.

332. **Perception and Knowledge.** A systematic study of basic problems in the philosophy of perception: perceiving as a mental state; the objects of perception; sensing, sensation, and sense-data; perception and the external world; perception as the basis of empirical knowledge. Traditional empiricist philosophies of perception are examined and contemporary criticisms and defenses are assessed. ¾ or 1 unit. Prerequisite: One course in philosophy. Swartz.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. ¾ or 1 unit. Turquette.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. ¾ or 1 unit. Prerequisite: Philosophy 333. Turquette.

335. **Social Philosophy.** The nature of social organization as seen from economic, moral, and political standpoints; various senses of freedom; relations between organization and freedom; the free society. ¾ or 1 unit. Prerequisite: One course in philosophy.

336. **Philosophy of Law and of the State.** ¾ or 1 unit. Prerequisite: One course in philosophy.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth; study of the functions of language, definition, meaning and verification, semantical paradoxes. ¾ or 1 unit. Prerequisite: A course in logic. FABER.

338. **Philosophies of Language.** Same as Linguistics 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

339. **Philosophy of Mathematics.** Introduction to some of the main philosophical problems and contemporary viewpoints concerning mathematical concepts, mathematical methods, and the nature of mathematical truths. The concept of infinity; conventionalism and formalism; the distinction between analytic and synthetic truths; necessity; mathematics and the problem of universals; other related topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

340. **The Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas*, taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

341. **Existentialism.** An introduction to contemporary philosophical existentialism. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. ¾ or 1 unit. Prerequisite: One course in philosophy.

361. **Comparative Religions: The Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

362. **Comparative Religions: The Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT, WAINWRIGHT.

PHYSICAL EDUCATION

The department offers programs of graduate study leading to the Master of Science in the teaching of Physical Education and the Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, in-

cluding sport, dance, and exercise. The Doctor of Philosophy program also permits candidates to specialize in the areas of health education, safety education, and recreation. (See Health and Safety Education, page 197, and Recreation and Municipal Administration, page 332.)

Admission requirements for a major in the field are: (1) a minimum grade-point average of 4.0 for the last sixty hours of undergraduate study (applicants whose averages are below 4.0 but above 3.75 are considered on an individual basis); (2) thirty hours of approved credit in physical education or related fields; (3) eighteen hours of approved undergraduate credit in science; (4) sixteen hours of undergraduate credit in education; and (5) a course in statistics or measurement. Graduate Record Examination aptitude and achievement test scores, as well as a Miller Analogies Test score, should be submitted to the department.

Master of Science in Physical Education. Candidates for the Master of Science in Physical Education must complete eight units including (1) four units in physical education or approved related courses (health education or recreation); (2) two approved thesis units in another discipline directed toward a specific research interest; (3) Physical Education 490, one semester, no credit; (4) thesis, two units.

Master of Science in the Teaching of Physical Education. Candidates for this degree must complete eight units including (1) four units in physical education or approved related courses (health education or recreation); (2) two units in education including History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; (3) Physical Education 490, one semester, no credit; (4) thesis, two units. The Master of Science in the Teaching of Physical Education option is designed to meet the needs of fifth-year students who do not intend to pursue the doctorate. See pages 41 and 42.

Candidates may petition to waive the thesis and seminar requirements, but they must take two additional units of credit and pass a final comprehensive written and/or oral examination in physical education and related fields.

Doctor of Philosophy. Requirements for this degree are twenty-four units of credit including (1) a minimum of eight units in physical education courses or approved related courses in health education, safety education, or recreation; (2) one minor for a minimum of four units, or two minors for a minimum of two units each; (3) Physical Education 490; and (4) presentation of an acceptable thesis of eight units.

GRADUATE FACULTY

Professors: E. F. Zeigler (Head of Department), Alyce T. Cheska, T. K. Cureton, Jr., A. W. Hubbard, Laura J. Huelster, H. E. Kenney, C. G. Knapp, D. O. Matthews, K. J. McCristal.

Associate Professors: G. Luschen, A. C. Moore, Jr., R. H. Pohndorf, R. E. Shelton, H. J. VanderZwaag, Olive G. Young.

Assistant Professors: A. W. Flath, R. E. Herron, W. Johnson, B. L. Rothermel, Marianna Trekell.

COURSES FOR GRADUATES

401. Administration of Physical Education and Sport. Analysis of completed research relating to theory and practice of administration in physical education and sport; the development of policy statements and procedures manuals for the various educational levels; experience in the use of the case plan of instruction as a teaching technique for the development of competencies and knowledges relating to human relations and administration in this specialized field. 1 unit. Prerequisite: Physical Education for Men (or Women) 204 or equivalent. Huelster, Matthews, Pohndorf, Zeigler.

402. **History of Physical Education and Sport.** An analysis of the research literature related to the historical foundations of physical education and sport; discussion of such persistent historical problems as the influence of economics, politics and nationalism, curriculum and methods of instruction, professional preparation, the healthy body, dance, the use of leisure, and amateur and professional sport. 1 unit. Prerequisite: Physical Education for Men (or Women) 209 or equivalent. FLATH, TREKELL, ZEIGLER.

406. **Philosophy of Physical Education and Sport.** Philosophical analysis of physical education and sport (with some reference to school health and recreation) in the light of the leading philosophical tendencies and possible implications for public and private education; analysis of completed research; includes delineation of one's personal philosophy and the use of philosophical analysis as a research technique. 1 unit. Prerequisite: Philosophy 101; History and Philosophy of Education 305. HUELSTER, VANDERZWAAG, ZEIGLER.

407. **Sport Psychology.** Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, preception and emotion in sport situations; review of literature; independent projects. 1 unit. Prerequisite: Psychology 100; Educational Psychology 211; consent of instructor. HUBBARD, YOUNG.

408. **Principles of Kinesiotherapy.** Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically prescribed clinical training; literature; research. 1 unit. Prerequisite: Anatomy, physiology, kinesiology and physiology of exercise, or consent of instructor. SHELTON.

451. **Scientific Foundations of Physical Fitness.** Scientific basis for physical fitness; analysis of fitness programs and fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. CURETON, POHNDORF.

452. **Scientific Analysis of Physical Education Activities.** Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. CURETON.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. **Seminar.** Lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders; presentation and criticism of student theses. No credit. CURETON, POHNDORF, TREKELL, VANDERZWAAG, STAFF.

493. **Special Projects.** Independent research on special projects. Offered summers as special group practicums. ½ or 1 unit. STAFF, VISITING FACULTY.

495. **Techniques of Research in Health and Physical Education.** Review and appraisal of common research procedures; application of statistical procedures, libraryme thods, evaluation procedures, and experimental methods. 1 unit. HUBBARD, POHNDORF, TREKELL, VANDERZWAAG.

499. **Thesis Research.** Preparation of theses in physical education. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. Problems of Facilities Planning, Construction, and Utilization. Physical education facilities as related to objectives of physical education; consultant services with planning committees and architects; cost factors in different types of construction; the use of standards as a check on and guide for planning; safety factors; changes in playing surfaces due to research; building and field maintenance problems. ½ unit. Prerequisite: Physical Education for Men or Physical Education for Women 204 or equivalent, or consent of instructor. KENNEY.

350. Theory and Practice of Exercise Therapy. Theory and practice of therapeutic exercise as it applies to physical rehabilitation of the physically handicapped; physiological and kinesiological principles of physical restoration; the physical educator's role as related to ancillary medical forces; problems and principles related to kinesiotherapy, preventive, adapted, and remedial physical education and athletic training. ½ unit. Prerequisite: Anatomy, physiology, physiology of exercise, and kinesiology; or consent of instructor. SHELTON.

PHYSICAL SCIENCES

A special program leading to the Master of Science in the Physical Sciences is available to meet the needs of secondary school teachers who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit are acceptable toward the degree. To qualify for the degree, a student must present at least one course in mathematics beyond calculus, for which calculus is prerequisite. In addition, he must have met the requirements for teacher certification.

Candidates for the Master of Science in the Teaching of the Physical Sciences, which is distinct from the program described above, must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include the following courses: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. The courses in the physical sciences and the electives—which must normally give graduate credit—must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 3.5. See pages 41 and 42.

Inquiries concerning these programs should be directed to Professor Don Secrest, 300a Noyes Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Physics.

There is opportunity for specialization in atomic and nuclear physics, including research with the betatrons, the cyclotron, and with radioactive sources; in nuclear magnetic resonance; in theoretical physics; in the physics of solids, including research on ionic crystals, metals, semiconductors, cryogenics, and surface physics; in plasma physics and aeronomy.

Requirements for admission to the Graduate College with a major in physics are twenty semester hours of physics, including Physics 321, 341, and 342, or the equivalent, and excluding courses in general physics, and an average of at least 3.75 for the last sixty hours of undergraduate work. Advanced undergraduate courses in light, thermodynamics, and atomic physics are strongly recommended.

The requirements for the Master of Science in Physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department.

Candidates for the Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Educational Psychology 311, 312, and one additional unit in education selected from History and Philosophy of Education 301, 302, 303, and 304. Students applying for admission must present an average of 3.75 for the last sixty hours of undergraduate work; applications of students with averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor G. M. Almy, 209 Physics Building. See pages 41 and 42.

For information concerning applied mathematics, see page 273; for information about biophysics, see pages 86 and 244. A doctoral program in chemical physics is described on page 95.

GRADUATE FACULTY

Professors: G. M. Almy (Head of Department), A. Abashian, F. T. Adler, J. S. Allen, D. Alpert, G. Ascoli, P. Axel, J. Bardeen, F. C. Brown, R. M. Brown, W. D. Compton, L. D. Fosdick, H. Frauenfelder, J. J. Gilman, D. M. Ginsberg, E. L. Goldwasser, A. V. Granato, R. Haag, P. Handler, A. O. Hanson, J. D. Jackson, L. P. Kadanoff, J. S. Koehler, L. J. Koester, P. G. Kruger, U. E. Kruse, L. S. Lavatelli, D. Lazarus, E. M. Lyman, D. E. Mapother, R. J. Maurer, B. H. McCormick, K. Nishijima, J. R. Pasta, D. Pines, D. G. Ravenhall, C. S. Robinson, G. A. Russell, C. T. Sah, R. D. Sard, C. B. Satterthwaite, R. O. Simmons, C. P. Slichter, J. H. Smith, J. N. Snyder, A. Wattenberg, H. W. Wyld, M. E. Wyman.

Associate Professors: A. C. Anderson, G. A. Baym, M. K. Brussel, J. H. Cahn, C. P. Flynn, E. A. Jackson, M. V. Klein, N. D. Peacock, M. J. Raether, H. J. Stapleton, A. I. Yavin.

Assistant Professors: P. G. Debrunner, F. M. Propst, R. L. Schult, D. C. Sutton, M. Wortis.

COURSES FOR GRADUATES

400. **Problems and Methods of Mathematical Physics.** Matrices and tensors; analytic functions of a complex variable; conformal mapping; contour integration; ordinary differential equations: solutions at singular points, contour integral solutions, asymptotic expansions; eigenfunctions and eigenvalues; partial differential equations: Laplace's equation, wave equation, diffusion equation, Green's functions; Legendre, Bessel, confluent hypergeometric Mathieu, and elliptic functions; elementary difference equations. 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342; or consent of instructor.

422. **Dynamics and Nonlinear Mechanics.** Hamiltonian mechanics: Lagrange equations, Hamilton's canonical equations, contact transformations, Lagrange and Poincare invariants, Hamilton-Jacobi equation and Huygens' principle; pertur-

bation theory, relaxation oscillations and stability of periodic motion, theory of cosmotron orbits, three-body problems. 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. Relativity and Cosmology. Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor.

435. Theory of Semiconductors and Semiconductor Devices. Same as Electrical Engineering 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

436. Selected Topics in Physics of Solids. The following topics are offered in rotation, one or two each semester.

(a) Imperfections in Metals. Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, on physical properties, on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) Imperfections in Ionic Crystals. Thoery of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) Magnetic Properties of Solids. Quantum theory of diamagnetism, paramagnetism, ferromagnetism; elements of magnetic resonance and relaxation. 1 unit. Prerequisite: Physics 482 and 490, or consent of instructor.

441. Electrodynamics. Electrostatics; Laplace's and Poisson's equations; boundary value problems; spherical harmonics; multiple potentials; dielectrics; microscopic and macrosopic fields; electric susceptibility; magnetostatics; magnetic multipoles; magnetic media; conducting media; Maxwell's equations; field energy and momentum; electromagnetic waves; reflection and refraction; dispersion; wave packets; causality; diffraction; wave guides and cavity resonators; simple aspects of magnetohydrodynamics and plasmas. 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. Electrodynamics. Special theory of relativity; covariant formulation of electrodynamics; charged particle dynamics; high energy particle accelerators; energy loss by charged particles traversing matter; multiple scattering; Lienard-Wiechert potentials; radiation by charged particles; radiation loss in particle accelerators; Thomson scattering; bremsstrahlung; Weiszacker-Williams method; inner bremsstrahlung; Cerenkov radiation; radiative reaction; natural line breadth; multiple expansion of radiation field; Lagrangian and Hamiltonian formulation of electrodynamics. 1 unit. Prerequisite: Physics 441.

455. Reactor Physics, I. Same as Nuclear Engineering 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections, diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

456. Reactor Physics, II. Same as Nuclear Engineering 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron

spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Physics 455 or consent of instructor.

462. **Statistical Mechanics and Kinetic Theory.** Single-particle distribution functions: classical and quantum mechanical systems, Boltzmann equation, virial theorem, equations of state for gases; formal theory: ensembles, identical particles, thermodynamics of simple systems, distribution functions; non-equilibrium problems: conservation laws and hydrodynamics equations, sound waves, transport coefficients; plasmas, normal Fermi fluid, superfluids, systems with internal degrees of freedom. 1 unit. Prerequisite: Physics 360 and elementary quantum mechanics, or consent of instructor.

463. **Low Temperature Theory and Quantum Liquids.** Normal Fermi liquids: equilibrium properties, transport equation, quasi-particle collisions, degenerate He , Landau theory; formal description of experimental measurements in neutral and charged Fermi liquids; superfluid Bose liquid: He II, rotating buckets, macroscopic description of superfluid flow, two-fluid model, first, second, and quasi-particle sound, vortex lines, microscopic theory; superconductivity: BCS theory, electrodynamics and coherence effects, superconductivity in metals, tunnel effect, flux quantization, microscopic theory of superfluid flow, vortices. 1 unit. Prerequisite: Physics 362 or 462, and 481, or consent of instructor.

465. **Plasma Physics.** Basic equations of magnetohydrodynamics; orbit theory; stability of plasma configurations; hydromagnetic waves; plasma oscillations; high-frequency instabilities; spontaneous fluctuation theory; Fokker-Planck equation; transport processes; oscillations in a magnetic field; interaction of electromagnetic waves with plasmas. 1 unit. Prerequisite: Physics 362 and 441, or Electrical Engineering 423, or consent of instructor.

467. **Atomic Collision Processes.** Same as Electrical Engineering 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photo-processes and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

470. **Introduction to Nuclear and Particle Physics.** Basic facts of photons, leptons, hadrons, conservation laws, types of interaction, particle production and stability symmetries, nuclear forces, and ground state properties; two-particle systems: electromagnetic interactions, bound states, and resonances; nucleon-nucleon and meson-nucleon interactions; nuclei: properties of low-lying states, models, resonant reactions, and direct processes; particles and weak interactions: multi-pion resonances, symmetry schemes, beta decay and other leptonic processes, strange particle decays. 1 unit. Prerequisite: Registration in Physics 482.

471. **Nuclear Physics, I.** Systematics of stable nuclei and the nuclear potential; properties of odd-A nuclei; spherical single particle shell model; residual interactions; collective states and deformed nuclei; summary of theory and experiment for low-lying states; momentum distribution of nucleons; fission. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

472. **Nuclear Physics, II.** Resonance reactions: fast and slow neutron cross sections, neutron and gamma widths, strength functions, giant dipole resonance, compound nucleus, and statistical model; direct reactions: optical model, elastic and inelastic scattering, polarization, angular correlations; spectroscopic factors, intermediate structure, isobaric analogs. 1 unit. Prerequisite: Physics 471.

475. **Particle Physics, I.** Particles: properties and systematics; S-matrix theory; application of symmetry and invariance principles to decays, production processes and polarization; collision processes; mesonic and baryonic resonances; symme-

try schemes; particle scattering at very high energies; theory of pion-nucleon scattering, dispersion relations, Mandelstam representation. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

476. **Particle Physics, II.** Electromagnetic interactions of particles, form factor, predictions of unitary symmetry; beta and muon decay and capture, conserved and partially conserved currents, neutrino interactions, weak interaction form factors; leptonic and non-leptonic decays of strange particles; neutral K-meson decays; current topics. 1 unit. Prerequisite: Physics 475.

480. **Quantum Mechanics, I.** Introduction to concepts of quantum theory, with applications. Review of classical Lagrangian mechanics; historical review of quantum phenomena, Bohr theory, and the wave nature of matter; Schrödinger wave equation; one-dimensional potential well and barrier penetration problems; three-dimensional problems, angular momentum, hydrogen atom; simple stationary state perturbation theory, perturbation of energy levels, Stark effect, normal Zeeman effect. 1 unit. Prerequisite: Physics 322 and 342; a course in atomic physics.

481. **Quantum Mechanics, II.** Principally applications to atomic and molecular structure. Electron spin; spin-orbit coupling, anomalous Zeeman effect; semiclassical treatment of emission and absorption of radiation with examples; selection rules, atomic spectra, x-ray spectra; Pauli principle, helium atom, exchange energy; periodic system of elements, Fermi-Thomas atom; diatomic molecules, electronic motion, vibrational and rotational motion, band spectra; simple collision problems, partial wave analysis. Born approximation. 1 unit. Prerequisite: Physics 480 or consent of instructor.

482. **Quantum Mechanics, III.** Formal structure of quantum theory; quantum theory of angular momentum, vector addition coefficients, simple tensor operators; collision problems, inelastic scattering, formal scattering theory; elementary treatment of quantization of the radiation field and the interaction of light with matter; introduction to Dirac electron theory. 1 unit. Prerequisite: Physics 481 and 422, or consent of instructor.

487. **Topics in Advanced Quantum Theory.** The following topics are offered alternately, but not every year.

(a) Advanced Quantum Mechanics. Relativistic quantum mechanics of a single particle; Dirac equation, Lorentz transformation, properties and bilinear covariants, bound state and scattering problems, Möller and Breit interactions, elementary radiation theory, relativistic photoeffect, bremsstrahlung, formal scattering theory. S-matrix, symmetry principles. 1 unit. Prerequisite: Physics 482.

(b) Quantum Field Theory. Field quantization; scalar and pseudoscalar meson field: electromagnetic field, Dirac field, interacting fields, electrodynamics; meson theory; interaction representation; S-matrix; covariant perturbation theory and Feynman diagrams; Compton scattering; Möller scattering; bremsstrahlung; pair annihilation; charge and mass renormalization; Lamb shift; anomalous electron magnetic moment; Heisenberg representation; dispersion relations; recent developments. 1 unit. Prerequisite: Physics 487a.

489. **Solid State Physics, I.** Introduction to the modern theory of crystalline materials. Topics treated include crystal symmetry, elastic and thermal properties of solids, optical properties, point defects and imperfections in crystals. 1 unit. Prerequisite: Physics 360, 362, 381, 480, or consent of instructor.

490. **Solid State Physics, II.** Introduction to band theory of solids, free electron model, electrons in periodic potential, cohesion, transport properties of metals and semiconductors, experimental methods for determining band structure. 1 unit. Prerequisite: Physics 481, 489, or consent of instructor.

491. **Solid State Physics, III.** Elementary excitations in solids; phonons, electrons, plasmons, excitons, spin waves, treated as elementary excitations in interaction with one another and with external fields and particles. 1 unit. Prerequisite: Physics 481.

497. **Individual Study.** Individual study in a subject not covered in course offerings may be arranged for credit by registration under this number. ½ or 1 unit.

498. **Special Topics in Modern Physics.** Seminar. Lecture courses in topics of current interest are given under this number. Subjects are announced in the Time Table. ½ or 1 unit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Modern Experimental Physics, I.** Techniques and experiments in the physics of atoms, atomic nuclei, molecules, the solid state, and other areas of modern physical research. 1 unit. Prerequisite: Physics 342; registration in Physics 381.

304. **Modern Experimental Physics, II.** Continuation of Physics 303. 1 unit. Prerequisite: Physics 303.

321. **Theoretical Mechanics.** Motion of a particle in one, two, and three dimensions with applications; Kepler's laws and planetary motion; scattering of particles; conservation laws; motion of a rigid body in two dimensions; statics of extended systems. Lectures and problems. 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics; registration in Mathematics 341, 345, or 349.

322. **Theoretical Mechanics.** Continuation of Physics 321. Moving coordinate frames, fictitious forces; special theory of relativity, conservation laws, particle motion and creation; rigid body motion in three dimensions; gravitation and earth motion; generalized coordinates and Lagrange's equations; constraints, small vibrations. 1 unit. Prerequisite: Physics 321.

341. **Electricity and Magnetism.** The fundamental laws are introduced using the vector notation stressing Maxwell's equations in the integral form. Topics covered with applications and problems include direct current circuits, circuit theorems, electric and magnetic fields, Gauss's Law, capacitance and inductance; energy and forces associated with these fields in free space and in matter. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. ½ or 1 unit. No credit is given to graduate physics majors. Prerequisite: General physics; credit or registration in Mathematics 341, 343, or 345, or consent of instructor.

342. **Electricity and Magnetism.** Continuation of Physics 341. Effects associated with changing fields and currents, Faraday's Law, displacement current, transient currents, complex variables in circuit analysis, coupled circuits, and circuit theorems; an introduction to the generation and propagation of electromagnetic waves and the wave equations. ½ or 1 unit. No credit is given to graduate physics majors. Prerequisite: Physics 341.

343. **Electronic Circuits.** The physics of vacuum tube and semiconductor devices; theory and application of these devices as linear circuit elements in power supplies, amplifiers, communication circuits and control circuits. Emphasis is on experimental techniques. Lectures, problems, and laboratory. 1 unit. Prerequisite: Physics 341 or consent of instructor.

344. **Electronic Circuits.** Continuation of Physics 343. Electronic instruments and techniques used in research in physics and digital computers; theory and experi-

ments emphasizing the use and design of nonlinear circuits, e.g., multivibrators, pulse generators, counters, etc.; theory of switching circuits; special topics. 1 unit. Prerequisite: Physics 343 or equivalent.

347. **Electromagnetic Theory and Boundary Value Problems.** Beginning with Maxwell's equations, this course treats electrostatic and magnetostatic boundary value problems and multipole expansions with orthogonal polynomials, boundary value problems in quasistatic and radiation fields, simple radiating systems, and scattering of scalar waves. 1 unit. Prerequisite: Mathematics 343 and 345, Physics 342 or Electrical Engineering 229; or consent of instructor.

360. **Thermodynamics.** Zeroth, first, second, and third laws of thermodynamics; applications to simple physical and chemical systems; thermodynamics inequalities and equilibrium; phase transitions. Lectures and problems. 1 unit. Prerequisite: General physics and calculus; senior standing in physics is advised.

362. **Kinetic Theory and Statistics.** A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose, Einstein, and Fermi-Dirac statistics and applications. 1 unit. Prerequisite: Physics 360 or consent of instructor.

366. **Aeronomy: Physics of the Upper Atmosphere and Space.** Same as Astronomy and Electrical Engineering 366. Structure and composition of the Earth's upper atmosphere; solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

371. **Light.** Wave optics: description and superposition of waves, coherence, interference, diffraction, polarization, and dispersion. Geometrical optics: image formation, optical systems, thick lens theory, image defects; applications to optical instruments. Lectures, problems, and laboratory. ½ to 1 unit. Prerequisite: General physics; Mathematics 345 or consent of instructor.

381. **Atomic Physics.** Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics covered include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345; registration in Physics 385 is recommended.

382. **Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. 1 unit. Prerequisite: Physics 381 or 383.

383. **Atomic Physics and Quantum Theory for Engineers.** Introduction to the basic concepts of quantum theory which underlie modern theories of the properties of materials. Topics covered include elements of atomic and nuclear theory, kinetic theory and statistical mechanics, quantum theory, and simple applications, atomic spectra and atomic structure, molecular structure and chemical binding. Lectures and problems. ¾ or 1 unit. Prerequisite: General physics; general chemistry; Mathematics 345 or equivalent.

385. **Introduction to Quantum Mechanics.** Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. 1 unit. Prerequisite: Mathematics 343, Mathematics 345, or consent of instructor; registration in Physics 381 is recommended.

386. **Atomic Physics and Quantum Mechanics, I.** Study of atomic phenomena integrated with an introduction to quantum theory; topics discussed include evidence for the atomic nature of matter and the properties of the Schröedinger equation, single particle solutions in one dimension, the hydrogen atom, perturbation theory, external fields, and atomic spectroscopy of outer electrons. 1 unit. Prerequisite: General physics; Mathematics 343 or 345, or consent of instructor.

387. **Atomic Physics and Quantum Mechanics, II.** Continuation of Physics 386. Topics treated include identical particles, spectral hyperfine structure, magnetic properties of matter, atomic spectroscopy of inner electrons, high energy photon effects, molecular binding and spectra, emission and absorption of light, and symmetry principles. 1 unit. Prerequisite: Physics 386.

PHYSIOLOGY AND BIOPHYSICS

See descriptions and course listings under Life Sciences, page 243.

PLANT PATHOLOGY

Graduate work leading to the Master of Science and Doctor of Philosophy is available in the Department of Plant Pathology. Students may choose a major, joint major, or minor in plant pathology. The following fields are available for specialization: diseases of field crops, forest and shade trees, fruit crops, ornamentals, turf and lawn grasses, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science must meet the general requirements of the Graduate College, present an acceptable thesis, and pass an oral examination before a committee of staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students are accepted with a grade-point average of 3.75. Applications of students with grade-point averages of 3.5 and below 3.75 are considered on an individual basis.

GRADUATE FACULTY

Professors: W. M. Bever (Head of Department), L. M. Black, J. C. Carter, J. W. Gerdemann, D. Gottlieb, A. L. Hooker, M. B. Linn, D. Powell, M. C. Shurtleff, H. H. Thornberry.

Associate Professor: D. P. Taylor.

Assistant Professors: D. W. Chamberlain, H. Jedlinski, J. D. Paxton, P. D. Shaw.

COURSES FOR GRADUATES

401. Diseases of Forest and Shade Trees. A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. Offered in 1968-1969 and in alternate years. ½ or 1 unit. Prerequisite: Plant Pathology 204 or consent of instructor. CARTER.

403. Physiology of Fungi. Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Plant Pathology 204, or equivalent; organic or biochemistry; mycology, and microbiology. GOTTLIEB.

404. Plant Virology. Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, straining, assay, filtration, and purification; control methods; sources of information; history of virology. ½ or 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Consent of instructor. THORNBERRY.

406. Genetics of Plant-Pathogen Interactions. The genetics and expression of resistance in plants to fungi, bacteria, viruses, nematodes, and other pathogens; variation and genetic systems in pathogens with particular emphasis on pathogenicity; complementary genetic systems; theory and practice of breeding disease resistant plants. Lectures, discussions, assigned reading, and term paper. 1 unit. Prerequisite: Plant Pathology 301 and Botany 210, or Agronomy or Horticulture 323, or consent of instructor.

417. Discussions in Plant Pathology. Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. ¼ unit. STAFF.

499. Thesis Research. Individual study and research required of all students working toward the Master of Science or Doctor of Philosophy in Plant Pathology. 0 to 4 units. Prerequisite: Plant Pathology 302 or equivalent. Work can be taken in the following areas, subject to approval of the staff member concerned:

(a) Biochemistry of Plant Disease. STAFF.
(b) Diseases of Corn; Genetics of Resistance. HOOKER.
(c) Diseases of Cereal Grains. BEVER, HOOKER, SHURTLEFF.
(d) Diseases of Forest and Shade Trees. CARTER.
(e) Diseases of Fruit Crops; Fungicides. POWELL.
(f) Diseases of Leguminous Crops; Root Diseases. GERDEMANN.
(g) Diseases of Turf and Lawn Grasses. BRITTON.
(h) Diseases of Soybeans. CHAMBERLAIN.
(i) Diseases of Vegetable and Canning Crops. LINN, SHURTLEFF.
(j) Nematode Diseases. TAYLOR.
(k) Physiology of Fungi; Antibiotics. GOTTLIEB, SHAW.
(l) Plant Virology. BLACK, JEDLINSKI, THORNBERRY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. For students desiring to study specific problems not assigned in other courses. ¼ to 1 unit; maximum accumulated credit, 2 units. STAFF.

302. Research Methods in Plant Pathology. Techniques for the isolation, identification, culture of, and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. ¾ unit. Prerequisite: Plant Pathology 204 or equivalent. PAXTON.

303. Plant Nematology. Experimental techniques, nematode anatomy, taxonomy, biology, and host-parasite relations; intensive study of selected groups including

foliar, stem, root-knot, and cyst nematodes; interaction with bacteria, fungi, and viruses in plant disease development; control principles. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent; an introductory course in zoology or biology. TAYLOR.

304. **Forest Tree Diseases and Wood Deterioration.** Symptoms, causal agents, and control of the major forest tree diseases; causes and control of wood deterioration. ¾ unit. GERDEMANN.

305. **Principles of Plant Disease Control.** A study of the basic concepts of both nonchemical and chemical methods used for the control of plant diseases. Lectures, discussions, and assigned reading. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Plant Pathology 204; Chemistry 102, 132 or 133; or consent of instructor. POWELL.

306. **Epiphytology and Diagnosis of Plant Diseases.** Detailed consideration of factors influencing the incidence and severity of diseases caused by fungi, bacteria, viruses, and nematodes; ecological factors as etiological agents, and techniques for determining the intensity of epiphytotics; plant disease identification. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent.

377. **Diseases of Field Crops.** Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent. HOOKER.

PLANT PHYSIOLOGY

Students may obtain the Master of Science or the Doctor of Philosophy degree specializing in plant physiology in the Departments of Agronomy, Botany, Horticulture, and Plant Pathology. A number of plant physiology courses are offered in these departments. Courses in biochemistry and other life sciences are recommended to enhance a student's training.

The following is a partial list of available fields of specialization in these departments: environmental physiology, developmental physiology, plant water relations, nitrogen metabolism, phosphorus metabolism, lipid metabolism, mechanism of ion absorption, photosynthesis, physiology of fungi, biochemistry of disease resistance, and mechanisms of action of plant growth hormones. Further information may be obtained from the heads of the departments listed above.

Fellowships and assistantships are available to qualified students.

POLITICAL SCIENCE

The Department of Political Science offers work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, political behavior, political theory and jurisprudence.

Admission to graduate work in political science requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. The student must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history).

The department also administers a program leading to the Master of Arts in Public Administration. A grade-point average of at least 3.75 and a study proposal

leading to a well-defined career or professional objective, approved by the department, are required for admission. The program is offered both in Urbana and through extramural classes in Springfield, and is matched to the individual needs and objectives of students. Programs for students without public service employment usually incorporate an internship of at least three months. Further details may be obtained from the department, 326 Lincoln Hall.

Graduate students in other departments who choose political science as a minor must have had at least six hours of undergraduate work in political science and three hours in other social sciences.

GRADUATE FACULTY

Professors: V. A. Thompson (Head of Department), R. Dangerfield, G. W. Fisher, S. K. Gove, C. B. Hagan, E. G. Lewis, P. Monypenny, R. E. Scott, C. F. Snider.

Associate Professors: M. Davis, J. F. Hough, G. Manner, S. S. Nagel, T. Page, D. G. Sullivan, G. T. Yu.

Assistant Professors: B. Glad, Willia E. Steslicke, M. G. Weinbaum.

COURSES FOR GRADUATES

400. Classics of Political Science. Reading, analysis, and discussion of leading works on politics and government. 1 unit. Staff.

401. History of Political Theories. Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. 1 unit.

402. History of Political Theories. Readings and analysis of the leading political thinkers from the middle of the seventeenth century to the present. 1 unit.

406. Municipal Administration. Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. 1 unit.

410. Problems in Rural Local Government. Research in selected topics. 1 unit. Snider.

412. Problems in State Government. Research in selected topics in American state government. 1 unit. Snider.

420. Formation of Public Policy. Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, judicial activity. 1 unit. Hagan.

421. Government and the Economic Order. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. 1 unit. Hagan.

425. Personality and Political Process. Rationality and its limits in political processes: the functions of symbols and myth in politics; political involvement and quiescence; nonrational elements in legislation and administration. 1 unit. Prerequisite: Consent of instructor.

426. Political Parties. Special problems in political parties; methods and materials of research in this field. 1 unit.

427. Psychological Base of Political Behavior. This course is intended to introduce the student to relations between psychological mechanisms and life history factors and individual or group political behavior. Topics covered include national loyalty and ideology, mass public and political involvement, political authority, and individual compliance. 1 unit.

431. Problems of British Government. Special topics relating to British government. 1 unit. LEWIS.

435. Problems in the Government of Soviet Russia. Special topics relating to the government of the Soviet Union. 1 unit. HOUGH.

440. Comparative Politics and the Political Process. The comparative study of selected national political systems or of specific institutional forces that influence the making and application of public policy in several countries. The countries studied and the legal and extra-legal political agencies considered vary according to the person conducting the seminar. 1 unit. Course may be repeated for credit not to exceed a total of three units. STAFF.

441. Politics in the Developing States. An examination of the political processes in the developing countries. The general problems arising in the transition from traditional societies to modern industrial states are examined to describe the typical patterns of political change. Special attention is given to contemporary literature and studies. 1 unit. Prerequisite: Consent of instructor. SCOTT.

442. Problems of Latin-American Politics and Government. Special topics relating to Latin-American politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. 1 unit. Course may be repeated for credit not to exceed a total of two units. Prerequisite: Political Science 431 or equivalent. SCOTT.

447. Problems of Asian Politics and Government. Special topics relating to Asian politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. 1 unit. Course may be repeated for credit not to exceed a total of three units. Prerequisite: Political Science 441 or equivalent.

450. Contemporary Governmental Problems. Special problems of current importance. Designed especially for students not majoring in political science. S; 1 unit. Course may be repeated for credit not to exceed a total of three units. STAFF.

451. Constitutional Law. Research in selected topics in the American constitutional system. 1 unit. Prerequisite: Political Science 351 or equivalent. NAGEL.

465. Problems in Administrative Management. An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

466. Current Administrative Theory. A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision-making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. 1 unit. MONYPENNY, THOMPSON.

471. Problems in International Organization. Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. 1 unit.

481. Foreign Relations of the United States. Special problems in the development and conduct of American foreign policy. 1 unit. DANGERFIELD.

484. International Relations. An analysis of the approaches and methods used in the study of international relations; the characteristics of states and of international systems; the problem of conflict and its resolution. 1 unit.

485. **International Law.** Research on selected topics. 1 unit. MANNER.

490. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit.

491. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political insitutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit. Prerequisite: Political Science 490.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. ½ to 3 units. STAFF.

495. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; the present state of research in political science. 1 unit. HAGAN, MONYPENNY.

496. **Political Concepts—Formulation and Measurement.** The course is designed to indicate the relevance of certain research techniques for answering questions of concern in political science and to indicate the range of tools available to the student. Problems in concept formation are discussed. Current methods of concept measurement are presented to the student in the context of political research problems. 1 unit. Prerequisite: Consent of instructor.

497. **Research Design and Techniques.** This course is intended to introduce the student to problems of research design, data collection, data analysis and interpretation, sampling, and some simple measures of statistical association and significance. 1 unit. Prerequisite: Political Science 496.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. ½ or 1 unit.

306. **Municipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. ½ or 1 unit. Prerequisite: Political Science 305, or Economics 102 and 103, or six hours of political science.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. ½ or 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; state functions; reorganization problems in the states; state-local relations; state finance; trends and prospects. Students are not goven credit for both Political Science 110 and 312. ½ or 1 unit. Prerequisite: Political Science 150 or 191. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. ½ or 1 unit. Prerequisite: Six hours of political science. HAGAN.

317. **The American Federal System.** The nature, justification, and problems of federalism; coordination of governmental efforts by contract, subsidies, and grants; comparison of federal systems. ½ or 1 unit. Prerequisite: Political Science 150 or 191. Fisher.

318. **Tax Politics and Administration.** Interactions among the administrative, legal, and legislative aspects of the fiscal decision-making process at federal, state, and local levels, with emphasis on current issues. ½ or 1 unit. Prerequisite: Political Science 150 or 191. Fisher.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. ½ or 1 unit. Prerequisite: Two courses in political science or in political science and economics. Hagan.

326. **American Political Parties.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor. Weinbaum.

328. **Introduction to the Study of Political Behavior.** An analysis of the interrelations of political attitudes and public policy formation. Special attention is given to the substantive areas of voting behavior, political leadership, and the rise of political mass movements. The course also includes a review of the literature on democratic and authoritarian personality types. ½ or 1 unit. Prerequisite: Political Science 150 or equivalent. Sullivan.

329. **Electoral Behavior.** A study of the social and psychological motivations behind the individual voting decision, with special emphasis on the relationships between the voting decision and social stability. ½ or 1 unit. Prerequisite: Six hours of political science. Miller.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. ½ or 1 unit. Davis, Lewis, Steslicke.

335. **Government and Politics of the Soviet Union.** Evolution, structure, and functioning of the Soviet system of government; the theories, structure, and functioning of the Communist party of the Soviet Union. ½ or 1 unit. Hough.

336. **Governments and Politics in Western Continental Europe.** An analysis of the major governmental systems of Continental Europe; the evolution, structure, and functioning of the political institutions of France, Germany, Italy, Spain, Switzerland, and the Scandinavian countries as illustrations of multiparty and dictatorial types of governments. ½ or 1 unit. Lewis.

337. **Government and Politics of China.** An introduction to the governments and politics of modern China. ½ or 1 unit. Prerequisite: Six hours of political science.

338. **Governments and Politics in the Middle East.** An analysis of the transformation of Middle Eastern society from Morocco to Iran as case studies in political modernization. The politics of the area is studied with special reference to causes and character of modernization, role of leadership, ideologies, and institutions; methods and theories for analyzing political systems undergoing fundamental transformation, and implications for United States policy. ½ or 1 unit. Prerequisite: Six hours of political science.

339. **Governments and Politics in Sub-Saharan Africa.** Analysis of major political systems in Africa south of the Sahara. Emphasis on the development of states and the modification of social and political systems. A general survey of the area is

supplemented by a focus on selected countries. ½ to 1 unit. Prerequisite: Six hours of political science.

340. **The German Political System.** Structures and processes of postwar German politics, with primary emphasis on West Germany; special attention is paid to foreign policy formulation and problems, particularly defense, the Berlin issue, reunification, and relations with Eastern Europe. ½ or 1 unit. Prerequisite: Knowledge of German helpful, but not necessary.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. ½ or 1 unit. Prerequisite: Six hours of political science. Scott.

343. **Political Systems and Structures of Latin-American Countries.** The political process, generally of selected Latin-American countries at different levels of political development, with stress on the interaction between political infrastructure and more formal agencies of government. May include cross-national comparison of the function of such factors as political culture, party system, bureaucracy, or the military establishment. ½ or 1 unit. Prerequisite: Political Science 342. Scott.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

346. **Theory and Practice of Communism.** A survey of the international Communist movement; the origins of modern communism and the nineteenth-century development of its doctrines; the Russian Revolution; Lenin and Stalin, the U.S.S.R. as a model for communism; the regional development of Communist parties. ½ or 1 unit. Wilson.

347. **Governments and Politics of Southeast Asia.** A comparative analysis of the political development of the countries of Southeast Asia, the lands to the east of India and south of China, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

348. **Government and Politics of Japan.** An introduction to the government and politics of modern Japan. ½ or 1 unit. Prerequisite: Six hours of political science.

349. **Governments and Politics of South Asia.** A comparative analysis of the political development of India, Pakistan, Ceylon, and the lesser lands of South Asia, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

350. **Introduction to Law.** An introductory study of the nature of law, the functions of private law, the functions of public law, social change and law, and the limits of effective legal action. ½ or 1 unit. Nagel.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. ½ or 1 unit. Prerequisite: Political Science 150 or 191. Nagel.

352. **Comparative Constitutional Law.** A comparative analysis of the constitutional law cases from a variety of countries with particular emphasis on how the cases have resolved issues relating to civil liberties and the allocation of power among

governmental bodies. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

354. **The Judicial Process.** A systematic analysis of legal, evidentiary, environmental, and personal factors that influence judicial decision-making, with particular emphasis on the application of the scientific method to the study of judicial behavior. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

355. **The Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

356. **Public Administration and the Judicial Process.** The scope of administrative powers and their relation to private rights. A comparison of the processes of decision in administrative agencies and in the courts; the interests served by each; the impact of judicial review of administrative decisions upon administrative procedure and policy; the constitutional and statutory bases of review; the legal accountability of public officers versus political accountability. ½ or 1 unit. Prerequisite: Political Science 305 or 351, or consent of instructor. NAGEL.

357. **The Process of Law Enforcement.** Problems in the procedure of law enforcement including the nature and ramification of crime; the nature and sources of law; character and types of criminal law; structure of the court system and its role in criminal enforcement; agencies of law enforcement—federal, state, and local; interstate crime control; the police and crime detection; prosecution of criminal offenses; problems of judicial procedure; and correctional procedures. ½ unit. Prerequisite: Political Science 150 or 151.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MONYPENNY, PAGE.

362. **Administrative Organization and Policy Development.** Dynamics of policy formulation in public administrative agencies; current developments in organizational theory and their significance for public administration; origin of public administrative organizations; interpersonal behavior; large-scale organizations and centralization; external support and opposition; policy formation and problems of compliance. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

365. **Government and Labor.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

366. **Tools of Public Management.** A critical survey of the tools of analysis available to overhead functions of public management in key areas of decision; emphasis on personnel administration and manpower utilization, budgetary processes and fiscal controls, and several methods of administrative analysis—organizational studies, procedures engineering, information processing, and operations research. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

371. **World International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the United Nations and related agencies and to their evolution from the League of Nations system. ½ or 1 unit.

372. **Regional International Organizations.** Descriptive and comparative analysis of various regional international organizations, their role in contemporary politics and their relationship to the United Nations system; structure, functions, and accomplishments of North Atlantic Treaty Organization, Southeast Asia Treaty Organization, Organization of American States, and other regional international organizations. ½ or 1 unit. STESLICKE.

380. **Comparative Foreign Policies.** An analysis of the formulation and substance of the foreign policies of select nations of the world. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. ½ or 1 unit. Prerequisite: Six hours of political science. GLAD.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. ½ or 1 unit. Prerequisite: Political Science 381 or consent of instructor. DANGERFIELD, GLAD.

383. **Soviet Foreign Policy.** A survey of Soviet foreign policy from 1917 to the present, with emphasis upon the forces shaping this policy. Special attention is given to the interplay of ideology and national interest in policy formulation. ½ or 1 unit. HOUGH.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. ½ or 1 unit. MANNER.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. ½ or 1 unit. MANNER.

387. **National Security Policy.** An examination of the organization and formulation of current American defense policy; the theory of deterrence, with special reference to American and Soviet military strategy; the problems of disarmament and arms control. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

388. **The Military and Politics.** The role of the military in national and international politics, with special attention given to theories of war and peace, civil-military relations, the military and the political development of Western and non-Western states, and the non-military uses of the military. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

390. **Methods of Political Analysis.** Presentation of the analytic processes in the development of concepts, hypotheses, and theories. Discussion of the derivation, formulation, and specification of research problems to be related to basic methodologies and modes of analysis. Applications to political science. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation, and the Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. ½ or 1 unit.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; anti-democratic thought and totalitarian regimes. ½ or 1 unit.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. ½ or 1 unit. Offered in 1967-1968 and in alternate years.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts, Master of Science, Doctor of Philosophy, and Doctor of Psychology.

Fields. Doctor of Philosophy programs are offered in the following special areas of psychology: general experimental psychology, personality, social psychology, psychological measurement, clinical and counseling psychology, industrial psychology, school psychology, child development, and psycholinguistics. The Master of Arts degree is awarded to students in the above programs as an intermediate degree.

Master of Science programs are offered in personnel psychology, applied experimental psychology, measurement psychology, school psychology, and clinical and counseling psychology.

The Doctor of Psychology program is restricted to clinical and counseling psychology.

Admission. The candidate for the Master of Arts or Doctor of Philosophy must meet the following departmental requirements: (1) a minimum of fifteen hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of 4.0, though this may be waived for a student from a highly selective institution; (5) high scores on the Graduate Record Examination. Preference is given to students who have taken mathematics beyond college algebra and two years of French, German, or Russian.

The candidate for the Master of Science program must ordinarily have completed an undergraduate major in applied psychology at the University of Illinois. Students with an average of 3.5 may apply.

The candidate for the Doctor of Psychology must meet the following departmental requirements: (1) a minimum of twenty hours in psychology; (2) a course in statistics and a course in tests and measurements; (3) a minimum of twenty hours selected from anthropology, economics, education, political science, social work, and sociology; (4) a grade-point average of 4.0, though this may be waived for a student from a highly selective institution; (5) high scores on the Graduate Record Examination.

Because it is necessary to limit admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements for any of the above programs.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The Master of Arts is awarded to candidates who complete satisfactorily eight units of work, including an acceptable thesis. The Doctor of Philosophy is awarded to candidates who go on to complete an approved program in their area of specialization and meet Graduate College requirements for the degree.

The Master of Science is awarded to candidates who complete satisfactorily eight units of work after completing an applied psychology undergraduate major at the University of Illinois.

The Doctor of Psychology is awarded in clinical and counseling psychology when the following requirements have been completed: (1) three years of full-time course work consisting of twenty-four to twenty-eight units, of which twenty units must be at the 400 level; (2) one summer session of orientation in a hospital or clinic plus one

summer session of practicum in a hospital or clinic; (3) a preliminary examination administered by a committee appointed by the Dean of the Graduate College; (4) one year of internship following the third year of course work; (5) a report on the year of internship (not a dissertation); (6) a final examination administered by a committee appointed by the Dean of the Graduate College.

TRAINEESHIPS

United States Public Health Service Traineeships in Child, Measurement, and Clinical Psychology. Graduate students, including first-year applicants, are automatically considered for these appointments. No application is necessary. Current stipends (tax-free) are: Level I, $1,800; Level II, $2,000; Level III, $2,400; Level IV, $3,000. The trainee has no duties other than full-time graduate work

Veterans Administration Traineeships in Clinical and in Counseling Psychology. First-year students are not eligible for these appointments. Applicants for advanced standing may apply for a traineeship by a letter addressed to the head of the Department of Psychology. The trainee works approximately half-time in a Veterans Administration hospital as a Civil Service appointee.

GRADUATE FACULTY

Professors: L. G. Humphreys (Head of Department), J. A. Adams, H. W. Ades, W. R. Ashby, W. C. Becker, S. W. Bijou, R. B. Cattell, F. Costin, D. E. Dulany, C. W. Eriksen, T. N. Ewing, F. E. Fiedler, W. M. Gilbert, G. R. Grice, H. W. Hake, R. Hamlin, J. Hirsch, J. McV. Hunt, W. E. Kappauf, S. A. Kirk, L. H. Lanier, J. E. McGrath, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, D. R. Peterson, H. C. Quay, I. D. Steiner, L. M. Stolurow, M. M. Tatsuoka, H. C. Triandis, L. R Tucker, L. P. Ullmann.

Associate Professors: C. E. Bereiter, R. S. Bogartz, J. B. Cohen, M. E. Fishbein, L. H. Ford, Jr., Alice K. Jonietz, W. E. Montague, K. E. Renner, D. T. Shannon, M. Wagman, M. W. Weir, J. S. Wiggins.

Assistant Professors: L. C. Ate, W. H. Batchelder, G. L. Clore, Jr., N. H. Eisen, F. Fehr, Anglea Folsom, G. Z. Greenberg, K. T. Hill, C. L. Hulin, L. A. Jakobovits, S. M. Nealey, G. L. Paul, R. J. Rose, K. G. Scott, R. L. Sprague, J. S. Werry, N. Wiggins.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all the prerequisites.

402. **Systematic Psychology.** A critical analysis and comparison of modern and contemporary psychological systems. 1 unit. Prerequisite: Twelve hours of psychology. Dulany.

403. **Proseminar in General Psychology, I.** A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. 1 unit. Prerequisite: Twelve hours of psychology. Staff.

404. **Proseminar in General Psychology, II.** Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. 1 unit. Prerequisite: Twelve hours of psychology. Staff.

408. Design of Experiments in Psychology. Advanced experimental designs in psychological research; special methods of data analysis. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Psychology 307. KAPPAUF.

409. Psychological Scaling. Same as Sociology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Psychology 307. BATCHELDER, TATSUOKA, TUCKER.

411. Advanced Physiological Psychology. Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation, learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. MEAD, O'KELLY.

415. Experimental Sensory Psychology. A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. GREENBERG, KAPPAUF.

416. Perception. Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpretations. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Twelve hours of psychology. HAKE.

417. Experimental Psychology of Learning, I: Basic Processes. A study of experimental investigation of basic learning processes, with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. 1 unit. Prerequisite: Twelve hours of psychology. GRICE.

418. Experimental Psychology of Learning, II: Human Learning. Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. 1 unit. Prerequisite: Psychology 417 or consent of instructor. ADAMS.

419. Advanced Comparative Psychology. A critical survey of techniques, results, and problems in the study of animal behavior and human behavior from the comparative-evolutionary point of view. Laboratory demonstrations and individual research problems. 1 unit. Prerequisite: Twelve hours of psychology or biology. HIRSCH.

421. Problems in Motivation. 1 unit. Prerequisite: Twelve hours of psychology. O'KELLY.

425. Psycholinguistics. Same as Communications and Linguistics 425. A critical survey of methods and theories in the psychological study of the communication process, with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. Research Seminar in Psycholinguistics. Same as Communications and Linguistics 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Psychology 425; consent of instructor. OSGOOD.

427. Engineering Psychology. Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent. HAKE.

428. Higher Process. An examination of method, theory, and research in the study of thinking; status of cognition as a construct; verbal control of behavior; concepts, problem solving, attention, language and thought; cognitive process: as a source of motivation. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. DULANY.

429. Second Language Acquisition and Bilingualism. An examination of the field from a psycholinguistic perspective. The following topics are discussed: first vs. second language acquisition, the nature of language apititude and competence, methods of second language teaching, the nature of bilingualism, and comparative psycholinguistics. 1 unit. Prerequisite: Consent of instructor. JAKOBOVITS.

431. Psychological Measurement in Industry. Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. 1 unit. Prerequisite: Psychology 307 or equivalent. HULIN.

435. Motivation and Morale in Industry. Same as Labor and Industrial Relations 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. NEALEY, TRIANDIS.

441. Personality and Behavior Dynamics. The cross-sectional structure of personality, the basic principles of behavior dynamics and the determinants which shape personality development are described. Special topics include typologies, trait measurement, conflict and anxiety, and mechanisms of defense. ½ unit. Prerequisite: Twelve hours of psychology. CLORE, WIGGINS.

442. Behavior Disorders. A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. ½ unit. Prerequisite: Psychology 338; consent of instructor. PAUL.

443. Psychodiagnostics, I. Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 390 or equivalent. BECKER, SHANNON.

444. Psychodiagnostics, II. Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. 1 unit. Prerequisite: Psychology 443; consent of instructor. BECKER, SHANNON, WIGGINS.

445. Behavior Modification. A critical survey of issues, principles, practice, and research related to modifying human behavior. The course covers psychoterapeutic and somatic approaches; symptomatic relief and personality-restructuring goal-orientations; individual, family, group, milieu, and preventive community intervention. ½ unit. Prerequisite: Psychology 444. Registration in Psychology 447 is strongly recommended. ULLMANN.

446. Laboratory in Behavior Modification. Practice in techniques of behavior modification with a focus on recent innovations. Research implications of the newer methods are examined. Small sections of the course are formed according to the specialized interests of students and staff. ½ unit. Prerequisite: Psychology 445.

447. Practicum. Supervised practice in the assessment and modification of problem behavior. ½ unit. A student may reregister for a maximum of one unit. Prerequisite: Credit or registration in Psychology 445 and 446. SHANNON.

456. Psychology of Social Communication. Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of

persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Six units of graduate credit in psychology including Psychology 351 or equivalent. STEINER.

459. **Leadership and Group Effectiveness.** Theories of leadership, methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Psychology 351 or equivalent. FIEDLER, HILL.

460. **Motivation and Personality Development in Children.** Theory, method, and research on the interaction of motivational personality, and learning processes and development in children, with emphasis on experimental studies and a social learning theory approach. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor.

462. **Human Abilities.** Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Psychology 307 or equivalent. HUMPHREYS.

463. **Research Methods in Clinical Psychology and Personality.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. ½ unit. Prerequisite:—Psychology 306 and 403. ERIKSEN, J. S. WIGGINS.

465. **Learning in Children.** An examination of laboratory investigations of children's learning, with emphasis on developmental changes as related to current theories of learning and development. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. WEIR.

467. **Personality Assessment.** Methods and theory in the quantitative assessment of personality; review of research findings and trends. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Psychology 307 or equivalent. BECKER, WIGGINS.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. GRICE.

469. **Cognitive Development.** An examination of laboratory investigations of cognitive development in children, with emphasis on current theories of cognition and language. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. L. COHEN.

470. **Principles and Methods of Teaching Psychology.** Designed for graduate students in psychology. Among the major areas considered are: developing course objectives and content; developing and presenting teaching-learning situations; evaluating the attainment of course objectives; advising and counseling students; ethics in teaching; research problems on the teaching of psychology. ½ or 1 unit.

Prerequisite: Second-year graduate standing in psychology or consent of instructor. COSTIN.

483. Psychology of Speech and Hearing Disorders, I. Same as Speech 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. Psychology of Speech and Hearing Disorders, II. Same as Speech 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

485. The Sampling of Human Populations and Social Organizations. Same as Sociology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples—stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

490. Individual Research. For graduate students who wish to conduct research on special problems not included in graduate theses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

492. Psychology of Learning and Instruction. Same as Educational Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON.

494. Multivariate Analysis in Psychology and Education. Same as Educational Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Education Psychology 496; consent of instructor. TATSUOKA, TUCKER.

495. Theory of Measurement. Same as Educational Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307, or equivalent; Educational Psychology 392 or Psychology 390, or equivalent. HASTINGS, TUCKER.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. Quantitative Methods, I. A lecture and laboratory course in the development and application of quantitative methods in psychological research. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. BATCHELDER, KAPPAUF, TATSUOKA.

307. **Quantitative Methods, II.** Continuation of Psychology 306. 1 unit. Prerequisite: Psychology 306. Batchelder, Kappauf, Tatsuoka.

311. **Physiological Psychology.** A survey of classical and current problems, with emphasis on the nervous and endocrine systems in information processing and in the regulation of behavioral adaptation, with examples from sensation, perception, motivation, emotion, and learning. Laboratory. ½ or 1 unit. Prerequisite: Six hours of psychology; **Physiology** 103 or 106, or Zoology 104. Mead.

323. **The Small Social Group.** Same as Sociology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theroetical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology or Psychology 201.

326. **Motivation and Emotion.** The nature and develpment of emotion, attitude, motive, and the role of these processes in social adjustment. ½ or 1 unit. Prerequisite: Six hours of psychology. J. Cohen, O'Kelly.

330. **Experimental Psychology, I.** A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. ½ unit. Prerequisite: Psychology 235. Greenberg, Hake.

331. **Experimental Psychology, II.** A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. ½ unit. Prerequisite: Psychology 235. Grice, Montague.

332. **Research Methods in Social Psychology.** Same as Sociology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology 201 or Sociology 201; Psychology 235 or Sociology 184 and 185. Fishbein, McGrath.

335. **Mathematical Formulations in Psychological Theory.** Mathematical formulations are illustrated by studying quantitative treatments of various psychological processes. Emphasis is on learning theory, psychophysical laws, and other selected topics. Simple mathematical tools are developed as required. ½ or 1 unit. Prerequisite: Elementary statistics or probability, elementary calculus, and six hours of psychology, or consent of instructor. Batchelder, T. Steiner.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. ½ or 1 unit. Prerequisite: Six hours of psychology. Peterson.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. ½ or 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. Hirsch, Mead.

346. **Behavior Genetics.** Examination of the relations between genetic mechanisms, population structure, and individual differences in behavior; survey of research and possible extensions of research on the genetics of behavior; laboratory work on techniques of behavior study and genetic analysis. ½ or 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. Hirsch.

348. **The Psychology of Learning.** A survey of the basic facts and theories of the learning process. ½ or 1 unit. Prerequisite: Six hours of psychology. Batchelder, T. Steiner.

351. **Advanced Social Psychology.** Same as Communications and Sociology 351. An integrative treatment of individual behavior variables in relation to group vari-

ables. 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235, or Sociology 385, or a comparable statistics course. McGrath, I. Steiner.

352. Attitude Theory and Measurement. Same as Communications and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. Theories and methods are evaluated with respect to empirical research in the area. 1 unit. Prerequisite: Sociology or Psychology 201; a course in statistics. Fishbein.

355. Industrial Social Psychology. Same as Labor and Industrial Relations 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid in understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 201 or 357. Triandis.

356. Human Factors in Equipment Design. The contributions of psychological research to the design of equipment for efficient human use and operation. Studies of the characteristics and limitations of the human individual which bear upon the equipment and machines best suited to his use. A survey of research on visual and auditory displays, controls, layout of consoles; complex man-machine systems; vigilance and isolation effects; design for efficient trouble-shooting and maintenance. Emphasis is placed upon the methods used in collecting data on these problems. Applications to engineering, industrial design, management, etc., are discussed. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. Greenberg.

357. Psychology of Industrial Conflict. Same as Labor and Industrial Relations 357. An analysis, in terms of behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. Hulin, Nealey.

358. Human Performance in Man-Machine Systems. Examination of equipment and training variables that influence the human operator and the effectiveness of man-machine systems; methods of task analysis for the systematic determination of behavioral requirements; design and use of simulators and other training devices; measurement of operator proficiency; control and display variables in closed-loop tracking systems; motor and perceptual fatigue; effect of work load; contemporary issues. Field trips. Research project on equipment design. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. Adams.

359. The Social Psychology of Organization. Same as Sociology 359. Analysis of the interrelationships between social and psychological factors, on the one hand, and organizational structure and process on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. McGrath.

360. Modern Viewpoints in Psychology. A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and psychoanalytic theory—as conceptions of man and as approaches to the study of learning, perception, personality, and social behavior. ½ or 1 unit. Prerequisite: Nine hours of psychology with an average grade of B, or consent of instructor. Dulany.

361. Advanced Developmental Psychology. Theory and research on psychological development from birth through adolescence; maturation of behavior systems;

the role of social learning in development; the effects of early experience on personality development; critical stages in development. 1 unit. Prerequisite: Psychology 216, 217; a course in statistics. HUNT, SCOTT.

371. **Psychological Factors in Political Behavior.** An application of psychological methods and theories to the study of political behavior. Special attention is given to research methods and to content problems in voting behavior and national security policy. ½ or 1 unit. Prerequisite: Six hours beyond 100-level courses in psychology, political science, or sociology.

373. **Human Development in Cross-Cultural Perspective.** Same as Anthropology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, psychology, or sociology, or consent of instructor. CASAGRANDE.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369.

386. **Methods of Field Research.** Same as Sociology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of psychology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupation, or general community activity and structure. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185.

390. **Psychological Tests and Measurements.** The measurement of human behavior in psychological studies; the construction and use of psychological tests; introduction to tests of intelligence, achievement, personality, and interest; practice in test construction, administration and validation. Lectures and laboratory. 1 unit. Prerequisite: Psychology 235. HULIN, WHIMBEY.

RADIO AND TELEVISION

The Department of Radio and Television offers work leading to the Master of Science in Radio and Television and the Master of Television. For the program leading to the Doctor of Philosophy in Communications, see page 118.

Admission to the program leading to the Master of Science requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in radio-television or a related field, English, or the social sciences; (2) a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

Admission to the program leading to the Master of Television requires (1) meeting minimum requirements for admission to the Graduate College; (2) a bachelor's degree from an accredited institution, ordinarliy with a major in radio, television, theatre arts, journalism, or some other area related to television; (3) the approval of an entrance committee.

Master of Science in Radio and Television. Requirements for this degree include:

(1) A major of four units or three units and one additional unit approved by the adviser.

(2) A minor of at least two units, normally in an area outside the College of Journalism and Communications.

(3) A one unit thesis.

(4) A minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field.

(5) A minimum total of eight units.

Master of Television. This degree differs from the Master of Science program in these ways: it does not require a thesis, but instead requires study in special problems of television; it does not require a minor, but permits concentration in the fifth year in the radio and television field.

Requirements for the degree include a total of eight units of credit, with a minimum of six units selected from courses in the television sequence.

A list of the specific courses that must be included in the Master of Science in Radio and Television and the Master of Television degree programs is available upon request from the department.

Students are expected to plan their programs around a special interest area which may include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

GRADUATE FACULTY

Professor: H. J. Skornia.

Associate Professors: H. V. Cordier (Head of Department), F. E. Schooley.

Assistant Professor: H. W. Lippold, Jr.

Instructor: B. L. Sims.

COURSES FOR GRADUATES

450. Special Problems in Television. Project work for advanced students in specific areas of television, including news, advertising, directing, writing, etc. 1 to 2 units. Prerequisite: A television course in the area of specialization; consent of instructor. Staff.

451. Television Program Management and Production. Problems in originating, planning, and producing television programs. 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor. Cordier.

462. Seminar in Radio and Television. Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. Skornia.

463. World Broadcasting. Same as Communications 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor. Skornia.

490. Special Topics in Radio and Television. ½ or 1 unit. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in radio-television. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

350. Broadcast Playwriting. Fundamentals of radio and television dramatic writing; adaptations and original projects in both media. ½ unit. Prerequisite: Consent of instructor. SMALLEY.

354. Television Directing. The theory and techniques of directing the television program. Experience in directing laboratory productions. ½ unit. Prerequisite: Radio-Television 252; consent of instructor. CORDIER.

355. Television News. News coverage, script preparation, use of visual materials, and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. ½ unit. Prerequisite: Consent of instructor. LIPPOLD.

356. Cinematography for Television. The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. Materials cost approximately $50.00. ½ unit. Prerequisite: Consent of instructor. SIMS.

360. Educational Uses of Television and Radio. Same as Communications and Educational Psychology 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

362. Radio and Television Station Management. A study of the organization and administration of the radio and television staff and station; public relations, personnel mangement, and station operation; analysis of station and agency relationships and radio and television sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. ½ unit. Prerequisite: Radio-Television 261. SCHOOLEY.

365. Radio News. News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. ½ unit. Prerequisite: Journalism 211. CRAMER.

366. Advanced Radio and Television Practices, I. Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. Advanced Radio and Television Practices, II. Continuation of Radio-Television 366. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. Radio and Television Regulation. Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. ½ unit. SCHOOLEY.

RECREATION AND MUNICIPAL PARK ADMINISTRATION

The Department of Recreation and Municipal Park Administration offers a program of graduate study leading to the Master of Science in Recreation. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in recreation, see page 302.) This program primarily prepares leaders, supervisors, administrators, teachers, and research workers in community recreation,

but it also offers opportunities for preparation in the related fields of park administration, therapeutic recreation and rehabilitation, outdoor recreation, and college union administration, as well as recreation work with private agencies, business and industry, commercial recreation enterprise, etc.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last sixty semester hours; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Requirements for this degree are eight units including (1) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science, psychology, social work, and sociology; (2) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (3) registration in and satisfactory completion of Recreation 490, without credit; (4) presentation of an acceptable thesis in recreation, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

GRADUATE FACULTY

Professors: A. V. Sapora (Head of Department), E. H. Storey.

Associate Professor: H. E. Weaver.

Assistant Professor: M. Virginia Frye.

COURSES FOR GRADUATES

401. Foundations of Recreation. Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. 1 unit. Prerequisite: Recreation 176 or equivalent.

402. Recreation Administration. Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent.

403. Evaluation of Recreation Resources and Programs. Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; research in the field of recreation. 1 unit. Prerequisite: Recreation 176 or 375, or equivalent; a course in tests and measurements or statistics. Sapora.

404. Outdoor Education and Recreation. Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. Weaver.

490. Seminar. Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. No credit. Staff.

493. Special Projects. Independent research on special projects. Open only to students majoring in recreation. ½ to 2 units. Prerequisite: Recreation 403 or equivalent. Staff.

499. Thesis Research. Preparation of theses in recreation. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. Introduction to Administration. Organization of public and private agency programs, leadership, facilities and services; introduction to recreation administration. ½ or 1 unit. Prerequisite: Recreation 176. RUHE, SAPORA.

385. Park Management. An intensive study of the principles, practices, and problems involved in managing public park systems. Designed to provide a professional background including the history of parks, organization, planning, examination of facility design and layout, maintenance, finance, and operaiton of park systems. ½ or 1 unit. Prerequisite: Landscaping Architecture 226, Urban Planning 171, Political Science 305, Recreation 278 and 279, or equivalent. OWENS, RUHE.

390. Principles of Therapeutic Recreation. Concepts, principles, objectives, methods, and settings of recreation for the ill and handicapped. ½ or 1 unit. Prerequisite: Recreation 176 and 208 or 209, or consent of instructor. FRYE.

395. Recreational Use of Public Lands. A study of lands in the public domain, and their historical, current, and potential use for outdoor recreation. It includes an analysis of land, woods, and water in the public domain; the demand for outdoor recreation; multiple use concept of natural resources; functions and policies of federal and state governments and their agencies; the economics of outdoor recreation; and the future of outdoor recreation in America. ½ or 1 unit. Prerequisite: Recreation 176, Geography 214, and Economics 108, or consent of instructor. STOREY.

RUSSIAN LANGUAGE AND AREA STUDIES

Graduate programs in Russian language and area studies are offered by the Center for Russian Language and Area Studies in cooperaiton with various departments.

Minor for the Master's Degree. A candidate for the master's degree who elects Russian language and area studies as a minor must earn at least two units of graduate credit in courses chosen from the following: anthropology, economics, geography, history, law, library science, political science, Russian, and sociology. The courses chosen must be in at least two departments.

Minor for the Doctor of Philosophy Degree. A doctoral candidate who elects Russian language and area studies as a minor must demonstrate a reading command of Russian as tested by examination or by completion of Russian 104 or 401 with a grade of A or B, and in addition must earn at least four units of graduate credit in courses chosen from the list given just above. The four units must include courses from at least two departments outside of, and may at the same time include up to one unit from within, the department offering the candidate's major.

Certificate of Graduate Specialization in Russian Language and Area Studies. This certificate is awarded by the Graduate College and the Center for Russian Language and Area Studies. It is for persons with the baccalaureate who are enrolled in advanced studies in any discipline and who wish at the same time to gain a knowledge of the Russian area and language. The requirements are: (1) A good command of written and spoken Russian, as determined by special examinations, or a grade of A or B in Russian 104 or 401. (2) At least six graduate units relating to Russia, distributed among at least three of the departments represented in the program (anthropology, economics, geography, history, law, library science, political science, Russian, and sociology) other than the student's own major department. If the student's major department is one of these nine he may count, as part of his six units, up to one unit from within his major department. (3) A special essay based largely on Russian sources, which must meet, at the minimum, the standard normally required in a master's thesis. The student may submit, in fulfillment of this requirement, a copy of his master's thesis or doctoral dissertation.

The adviser for the graduate minors and the Certificate is Professor Ralph T. Fisher, Jr., Director of the Center for Russian Language and Area Studies, 1207 West Oregon Street, Urbana.

GRADUATE FACULTY

Professors: R. T. Fisher, Jr. (Director of Center for Russian Language and Area Studies), C. L. Dawson, J. D. Fellmann, Z. Folejewski, D. R. Hodgman, E. G. Lewis, D. B. Shimkin, A. Vucinich.

Associate Professors: E. C. Bristol, K. Klein, T. Pachmuss.

Assistant Professors: F. Y. Gladney, S. P. Hill, P. B. Maggs, B. Uroff.

SLAVIC LANGUAGES AND LITERATURES

(Including Russian, Slavic, and Ukrainian)

The Department of Slavic Languages and Literatures offers graduate work leading to the Master of Arts in Russian, Master of Arts in the Teaching of Russian, and Doctor of Philosophy in Russian.

Students with a minimum grade-point average of 4.0 are regularly admitted to graduate courses, subject to fulfillment of other prerequisites. Students with a grade-point average between 3.5 and 3.99 are admitted upon approval of the department.

Students electing Russian as a major subject should have had the equivalent of at least four years of Russian in college, including practical work in the use of the language and an advanced course in literature.

Students choosing Russian as a minor subject should consult the department.

Master of Arts in Russian. In addition to fulfilling the general requirements of the Graduate College, candidates must pass both a written and an oral examination. Students may major in literature or linguistics and may offer a minor. Students majoring in literature must present at least two courses in linguistics; those majoring in linguistics must present at least two courses in literature, and in addition, some training in another Slavic language.

Master of Arts in the Teaching of Russian. Candidates for this degree are required to take: (1) Russian, five units: up to three units from 300 courses and at least two units from courses open only to graduates; (2) Education, two units: Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 303, 304, 305; (3) electives, one unit. These courses must be selected with the approval of the adviser. Candidates must pass an examination based on their course work and on a reading list. See pages 41 and 42.

Doctor of Philosophy in Russian. All candidates for this degree must fulfill the general requirements of the Graduate College and must have a reading knowledge of French and German. A student may major in literature or linguistics, but must offer a minor, preferably in another language or literature, comparative literature, or linguistics. Those students majoring in literature must present at least four courses in linguistics, as well as training in another Slavic language; students majoring in linguistics must present at least four courses in literature, along with some training in two other Slavic languages.

GRADUATE FACULTY

Professors: C. L. Dawson (Head of Department), Z. Folejewski.

Associate Professors: Evelyn Bristol, K. Klein, Temira Pachmuss.

Assistant Professors: F. Y. Gladney, S. P. Hill.

Russian

COURSES FOR GRADUATES

400. **Beginning Russian for Graduate Students.** Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit.

401. **Readings in Russian for Graduate Students.** Grammar, vocabulary, general and special readings. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit. Prerequisite: Russian 400 or equivalent.

406. **Russian Morphology.** A survey of the various parts of speech of modern standard literary Russian with special emphasis on the nominal and verbal systems. 1 unit.

407. **Russian Syntax.** A survey of historical and contemporary Russian syntax. 1 unit. Prerequisite: Consent of instructor or head of department.

410. **Literature of the Eleventh to the Sixteenth Century.** Reading of texts. Historical and literary background of the period. 1 unit. Prerequisite: Consent of of instructor or head of department.

412. **Literature of the Seventeenth and Eighteenth Centuries.** Reading of texts. Historical and literary background of the period. 1 unit.

413. **Modern Russian Drama.** A study of the Russian theatre from the eighteenth to the twentieth century. Plays by Russian authors are examined against the background of Russian and Western dramatic theories. 1 unit. Prerequisite: Consent of instructor or head of department.

414. **Pushkin.** The age of Pushkin; Pushkin's works in historical and comparative perspective; textual criticism, linguistic and structural analysis, intellectual interpretation, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

415. **Dostoevsky.** Dostoevsky: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

416. **Studies in Russian Criticism.** 1 unit. Prerequisite: Consent of instructor or head of department.

417. **History of the Russian Language.** 1 unit. Prerequisite: Russian 405.

419. **Tolstoy.** Tolstoy: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

420. **Chekhov.** Chekhov: historical background; textual criticism; structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

421. **Seminar in the Russian Novel.** Dostoevsky, Tolstoy, nineteenth-century novel, twentieth-century novel. 1 unit. May be repeated for a total of three units. Prerequisite: Consent of instructor or head of department.

423. **Seminar in Russian Poetry.** Pushkin, narrative verse, lyric verse, symbolism. Course may be repeated for credit not to exceed three units. 1 unit. Prerequisite: Consent of instructor or head of department.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Russian Phonetics and Diction.** Theoretical and practical work on pronunciation and intonation in Russian, with special attention to the problems of teachers. ½ unit. Prerequisite: Russian 212 or consent of instructor.

311. **Advanced Russian Conversation.** Practice in free conversation with a native speaker. ¼ unit. Prerequisite: Three years of college Russian, including Russian 211 and 212, or consent of instructor.

312. **Soviet Literature in Translation.** Survey of Russian literature since the 1917 Revolution; cultural and historical background of the period. No knowledge of the Russian language is required. ½ unit.

313. **Advanced Russian Composition.** Practice in advanced composition and study of advanced problems of grammar, syntax, and style. ¼ unit. Prerequisite: Three years of college Russian, including 213 and 214, or consent of instructor.

321. **Readings in Russian Literature: Pushkin, Lermontov, Gogol.** Representative works of the period 1820-1850; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

322. **Readings in Russian Literature: Dostoevsky and Tolstoy.** Representative works in their historical and cultural contexts. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

323. **Readings in Russian Literature: Turgenev, Goncharov, Ostrovsky.** Representative works of the period 1850-1880; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

324. **Readings in Russian Literature: Chekhov, Gorky, Blok.** Representative works of the period 1880-1917; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

325. **Readings in Soviet Literature.** Representative works of Russian literature since 1917: Mayakovsky, Leonov, Sholokhov, and others; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 202 or consent of instructor.

326. **Masterpieces of Russian Literature.** Masterpieces of Russian literature: historic background, textual analysis, structure, philosophy and ideology, aesthetic evaluation. This course is designed primarily for students in teacher training programs. ¾ unit. Prerequisite: Russian 201 and 202.

332. **Traditions of Russian Literature and Thought.** The rise and development of Russian social and philosophical thought in the nineteenth century and its impact on literature. ¾ unit. Prerequisite: Consent of instructor.

333. **The Russian Short Novel.** Theory and techniques of the *povest'* and related forms in the nineteenth and twentieth centuries. S; ½ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

Slavic

COURSES FOR GRADUATES

405. **Old Church Slavonic.** Analysis of grammar, reading of texts, discussion of development of the Slavic languages. 1 unit. Prerequisite: Slavic 380.

418. **Oral Poetry and Slavic Poetics.** Linguistic material and poetic form. Oral poetry in its genres, motifs, and themes; their unity and diversity in the cultural history of Slavic peoples; the impact of oral poetry on literary tradition. 1 unit.

460. **Comparative Slavic Phonology.** The phonological structure of Common Slavic at the time of dissolution of the primitive Slavic community; the characteristic tendencies in the evolution of sound and prosodic systems in the East, West, and South Slavic language groups; the phonemic patterns of single modern Slavic languages outlined as a basis for a typological classification of Slavic languages. 1 unit. Prerequisite: Slavic 380.

461. **Comparative Slavic Morphology.** A lecture course designed to trace the development of the principal parts of speech, their various inflectional and derivational

morphemes and their attendant grammatical categories from Common Slavic to the various modern Slavic languages, and to make comparisons among the modern synchronic morphological treatments of these languages. 1 unit. Prerequisite: Slavic 460.

491. Individual Topics. ¼ to 2 units. Prerequisite: Graduate standing with a major or minor in Russian.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

331. Slavic Civilization and Literatures. A survey of Slavic institutions and life as reflected in Slavic literatures other than Russian (Polish, Czech, Ukrainian, etc.,) and their connection with Russian traditions. ¾ unit. Prerequisite: Reading knowledge of Russian or one other Slavic language, or consent of instructor.

380. Introduction to Slavic Linguistics. Same as Linguistics 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit.

382. Language Laboratory Techniques. Same as French, German, and Spanich 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. S; ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent.

Ukrainian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

396. The Structure of Ukrainian. Ukrainian phonology, morphology, and syntax presented with Russian as a background and basis for comparison of these two East Slavic languages. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Russian 104 or equivalent.

398. Readings in Ukrainian Literature. Representative works of Ukrainian literature and their historical and cultural background. ¾ unit. Offered in 1967-1968 and in alternate years. Prerequisite: Ukrainian 396 or consent of instructor.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including anthropology, economics, geography, history, philosophy, political science, psychology, social work, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. At least three of the eight units required for this degree must be in 400 level courses, with at least two of these three units in the major. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chariman of the

committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may consitute, through registration in research courses, part of the four units of work required for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor J. B. Casagrande, 137b Davenport Hall. The general adviser for this degree is Professor George Manner, 321 Lincoln Hall.

Master of Arts in the Teaching of Social Studies. Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. The courses in the social studies should be selected from not more than three of the following fields: history (two units required), economics, geography, philosophy, political science, and sociology. The courses in education must include Educational Psychology 311, 312, Secondary and Continuing Education 456, and History and Philosophy of Education 304 and 305. The courses in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. See pages 41 and 42.

The adviser for candidates for this degree is Professor Charles E. Nowell, 310 Armory.

SOCIAL WORK

The Jane Addams Graduate School of Social Work offers two years of graduate professional study leading to the Master of Social Work. Although the basic curriculum of the School is the same for all students, there are opportunities for specialization in casework and group work. Students specializing in group work have their classes on the University of Illinois Chicago Circle campus and field placements in group work agencies in the city. Those specializing in casework may have classes on either the Urbana or Chicago campus, with field placements in selected agencies nearby.

The School has established an admissions committee which is responsible for reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. The applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthful relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

The School is compelled to limit enrollment to the number of field work placements available.

The courses listed on page 340 describe the program offered on the Urbana campus. Similar courses are offered in Chicago under a quarter term calendar, and the group work sequence is offered only there. For information about the Chicago program, the School's special catalog should be consulted.

Application must be made to the Jane Addams Graduate School of Social Work. The special catalog issued by the School may be obtained by writing to the Director,

Jane Addams Graduate School of Social Work, University of Illinois, 1207 West Oregon Street, Urbana.

GRADUATE FACULTY

Professors: M. P. Hale (Director of the Jane Addams Graduate School of Social Work), Jennette R. Gruener, Florence L. Poole, W. P. Simon.

Associate Professors: Lela B. Costin, Margaret G. Holden, D. E. Lathrope, J. E. McDonald, Aleanor R. Merrifield, Mary E. Sullivan, M. A. Taber, L. Jane Wille.

Assistant Professors: J. J. Alderson, Eloise J. Cornelius, S. Mirelowitz, H. Treger.

COURSES FOR GRADUATES

421. **Social Casework, I.** Analysis and study of philosophy, concepts, principles, and methods of social casework; role of caseworker in offering service; psychological and cultural factors affecting treatment; analysis of relationship, study-diagnosis, and treatment. ½ to 1 unit.

422. **Social Casework, II.** Casework principles and methods with emphasis on work with clients with complex emotional and personality problems: the stresses which impair social and ego functioning; the effects of agency setting. Casework methods as adapted to treatment of children and their parents, adults, the neurotic and mentally ill, the delinquent; multiple client interviewing and family diagnosis and treatment. ½ to 1 unit. Prerequisite: Social Work 421.

423. **Social Work Methods, III.** Emphasis is on the student's understanding and skill in social work with broader consideration of practice in various settings. Section A1 is required of all students; Sections B1 and B2 of casework majors. 2 to 4 units. Prerequisite: Social Work 422.

Section A1. Social Work Practice. Social work method in different settings. Ways of determining the nature and content of social work services in various settings; methods of developing effective working relationships in multi-discipline settings. Consideration of content specific to various kinds of agencies in which social work is practiced. ½ unit.

Section B1. Social Casework. Continuation of Social Work 422, Section B1, with increased emphasis on the generic, diagnostic, and differential treatment aspects of social casework. Application of the case study method to a variety of settings in which social casework is practiced. ½ unit.

Section B2. Field Instruction. Based on the student's own practice in a setting related to his field of specialization. Emphasis is on enhancing the student's skill in practice. 1 unit.

424. **Social Work Methods, IV.** Continuation of Social Work 423. Section A1 is required of all students; Sections B1 and B2 of casework majors. 2 to 4 units. Prerequisite: Social Work 423.

Section A1. Social Work Practice. Social work practice in areas of supervision, consultation, and administration. Emphasis for the casework student is on the understanding of the worker's role in consultation, policy-making, program planning, and interpretation. ½ unit.

Section B1. Social Casework. Continuation of Social Work 423. Section B1. Learning experiences arranged to assist the student to a greater integration of the philosophy, concepts, and principles in social casework. ½ unit.

Section B2. Field Instruction. Continuation of the third semester of field instruction. 1 unit.

425. Group Process and Method. Small group theory and the group process; the use of group process and methods in social work practice. ½ to 1 unit.

426. Social Planning and Administration. Principles, concepts, and methods of planning and administration of social services; emphasis on leadership, policy and decision making, and program organization. ½ to 1 unit.

427. Social Research. Objectives of social research, design of experiments, and measurement and methods of collecting data; design of questionnaires and schedules; methods of data analysis including statistical hypothesis testing and applications of inferential techniques; interpretation of results; preparation of reports. ½ to 1 unit.

451. Human Growth and Behavior, I. The major forces influencing the growth and behavior of the individual from birth through adulthood; sociocultural, familial, physical, emotional, and intellectual factors as they enhance or retard social functioning; the nature and dynamics of social process as related to growth and behavior; the relevance of this content to social work practice. 1 to 1½ units.

452. Human Growth and Behavior, II. Inter-relationship of physical, emotional, and social aspects of selected disease and implications for the patient, family, and community; psychopathology, including neuroses, psychoses, character disorders, psychosomatic dysfunction, organic conditions, and mental retardation; diagnosis and treatment methods, including psychotherapy, somatic and drug therapies, and social work. 1 to 1½ units. Prerequisite: Social Work 451.

453. Dynamics of Human Development, II. Understanding of deviations from normal physiological functioning as demonstrated in major chronic disease processes. Interrelationship of physical, emotional, and social aspects of causation of disease and implications for the patient, family, and community. Discussion of the role of the social worker in collaboration with other disciplines concerned with provision of medical and rehabilitative services. 1 to 2 units. Prerequisite: Social Work 451.

454. Dynamics of Human Development, III. Concepts and theories used in social work to understand the nature and causes of emotional pathology in social functioning. 1 to 2 units. Prerequisite: Social Work 453.

461. Special Studies in Social Work, I. Independent or group study in areas of special interest; application of social work principles to special problems or settings. 1 to 2 units.

462. Special Studies in Social Work, II. Independent or group study in areas of special interest; application of social work principles to special problems or settings. 1 to 2 units.

466. Field Instruction, I. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and indirect service to agency clientele. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 421.

467. Field Instruction, II. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and indirect service to agency clientele. ½ to 1 unit. Prerequisite: Social Work 421 and 466; credit or registration in Social Work 422.

468. Field Instruction, III. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Social Work 422, 466, and 467.

469. Field Instruction, IV. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Social Work 422, 466, 467, and 468.

481. Social Services and Welfare Policy, I. The function, nature, and scope of the social welfare institution; the social services as a response to social, personal, and economic problems of people; effects of economic and social growth and change on the welfare enterprise; current provisions of money aid programs and services for the aged, children, court wards, and the mentally and physically ill. 1 to 1½ units.

482. Social Services and Welfare Policy, II. Critical evaluation of current social services and welfare policy issues and alternatives for their solution; methods of planned change in the resolution of policy issues. ½ to 1 unit. Prerequisite: Social Work 481.

483. Social Welfare Organization, III. Examination of proposals to strengthen programs and services in each of the national, state, and community social welfare programs in the light of evolving needs and changing resources. Consideration of public health, medical care, health insurance, chronic illness and disability, rehabilitation services, mental health care, services for children, urban renewal, programs for the aging, correctional services, and informal education and leisure-time programs. 1 to 2 units. Prerequisite: Social Work 482.

484. Social Welfare Organization, IV. Analysis of organizational patterns and of the administrative process; study of the structures of international, national, state, and local public and private agencies to reveal their functions and interrelationships; review of the administrative process through examination of policy formulation, the executive function, organization, coordination, field services, personnel, budgeting, and public relations. Social action and the legislative process, and current developments and issues in the area of social work are examined. 1 to 2 units. Prerequisite: Social Work 483.

491. Research Seminar. Seminar for students preparing research projects, either in groups or individually. Experience in the application of research methods to current social work problems. 0 to 2 units. Prerequisite: Social Work 421 and 422, Section A2.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Introduction to Social Casework. Behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of these upon the contacts of social caseworkers with individuals and families. Attention is given to case records selected from social casework practice in public assistance and other community agencies. ½ unit.

316. Social Services for Children. Unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard-setting in social services for children. ½ or 1 unit. Prerequisite: A major in any of the social sciences, education, recreation, speech correction, or consent of instructor.

333. Introduction to Social Group Work. Background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. ½ unit. Prerequisite: Introductory courses in sociology, psychology, and social sciences.

SOCIOLOGY

The Department of Sociology offers graduate work leading to the Master of Arts and Doctor of Philosophy.

In order to be considered for admission, students intending to major in sociology must offer:

(1) A grade-point average of at least 4.0 (applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis);

(2) A minimum of nine semester hours of undergraduate work in sociology;

(3) One or more courses in quantitative research methods in sociology;

(4) Fifteen semester hours in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

The prerequisite for a graduate minor in sociology is six hours of undergraduate work in sociology.

Master of Arts. The requirements for the Master of Arts are: (1) eight units, including Sociology 385, 386, and 400, and no more than one unit of thesis credit; (2) passing the departmental comprehensive examination on the master's level; (3) preparation of an acceptable thesis; (4) passing an oral examination on the thesis.

Doctor of Philosophy. Study for the doctorate must include Sociology 385, 386, 387, and 400, or equivalent. A manual for graduate students in sociology is available from the department.

GRADUATE FACULTY

Professors: D. Glaser (Head of Department), B. Farber, C. L. Folse, J. R. Gusfield, J. E. Hulett, Jr., N. G. Jacobs, H. M. Johnson, B. Karsh, A. Vucinich.

Associate Professors: D. Bordua, J. P. Clark, Rita Simon, H. Y. Tien.

Assistant Professors: Shirley M. Clark, N. K. Denzin, K. W. Dickman, T. J. Duggan, G. J. McCall.

COURSES FOR GRADUATES

400. General Sociology. Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. 1 unit.

407. Population Studies and Demographic Analysis. Same as Rural Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. Folse.

409. Psychological Scaling. Same as Psychology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Psychology 307. Tucker.

411. Sociology of Science. Social factors in the origin of broad theoretical orientations in science, such as the mechanistic doctrine, vitalism, historicism, atomism, holism, relativism, and indeterminism; social effects of these orientations; the social

origin of scientists; ethos of science; the relationship of science to culture change; the variety and nature of scientific institutions. 1 unit. Prerequisite: Sociology 311 or consent of instructor. VUCINICH.

412. **Seminar on Social and Cultural Relations of Personality.** Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. 1 unit. HULETT.

414. **Seminar on Social Interaction.** Same as Communications 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

417. **Seminar in the Sociology of Law.** Review and analysis of selected areas of theory and research in the sociology of law. The focus varies from year to year. Topics covered in different years include such areas as civil litigation and the civil courts, police operations and the sociology of law and order, sociological theories of justice and the operations of legal agencies. Students should consult the instructor about the area to be covered in a particular semester. 1 unit. Prerequisite: Sociology 317. BORDUA.

418. **Seminar in Industrial and Economic Sociology.** Same as Labor and Industrial Relations 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Sociology or Labor and Industrial Relations 318, or consent of instructor. GUSFIELD, KARSH, PHILLIPS.

421. **Seminar on Research in Marriage and Family Life.** Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. 1 unit. Prerequisite: Consent of instructor. FARBER.

422. **Theory of Social Groups.** A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. 1 unit. MCCALL.

424. **Sociological Analysis of Treatment Institutions.** Analysis of research on the social structure of prisons, training schools, and mental hospitals; sociological approaches to measuring the effects of innovations in institution organization and program; measuring the influence of institutional experience on the post-release behavior of its inmates. Class makes one or more trips to institutions; total travel costs per student for the term not to exceed $10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of intructor. DENZIN, DEVRIES, GLASER.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology. JOHNSON.

426. **Sociological Research on the Extramural Treatment of Deviant Behavior.** Analysis of sociological research on community programs for the treatment and prevention of deviant behavior, including adjudication and disposition in delinquency and mental disorder, probation, parole, out-patient and day- or night-only care, work-release, community correctional treatment. Class makes one or more trips to observe field research; total travel cost for the term not to exceed

$10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of instructor. DENZIN, DEVRIES, GLASER.

429. Seminar in the Sociology of Religion. Detailed examination of research in the sociology of religion; the substantive character of religious groups and institutions as revealed by this research; significance of the research in the light of sociological theory and of other fields of sociological concern; the value of the current research methodology. 1 unit. Prerequisite: Sociology 400.

431. Seminar on Social Deviance. Systematic analysis of advanced theory and research on the social processes by which behavior becomes defined as deviant, the conditions promoting such behavior, and the career patterns of deviant persons, with particular attention to crime, delinquency, and mental disorder. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor. BORDUA, CLARK, GLASER, SIMON.

432. Special Problems in Theory and Research on Deviant Behavior. A seminar concerned with the critique of recent theory and research on selected problems in the study of delinquency, crime and mental disorder, and the collaborative development of new theory and research designs. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor.

435. Field Instruction in Sociological Research on Treatment of Deviant Behavior. Problems of designing and conducting sociological research in agencies for the treatment of deviant behavior (prisons, training schools, police departments, courts, mental clinics, mental hospitals); supervised training and practice in the functions of sociologists in these agencies. Application for admission to this course should be made early, preferably no later than the April prior to the summer session in which enrollment is desired, so that field placement arrangements can be made. S; 1 unit. Students may reregister in a subsequent summer for a second unit of credit, provided there is appreciable contrast in their two field locations. Prerequisite: Sociology 431, 333, and 424, or consent of instructor.

440. Political Sociology. An analysis of the impact of social cleavages and cohesion on the operation of political institutions and movements; the place of conflict and power in sociological theory; composition and behavior of power elites; participation in political associations; national and local power structure; social functions of electoral behavior; modern national and mass political movements. 1 unit. Prerequisite: A course in sociological theory or consent of instructor. GUSFIELD.

444. Seminar in Public Opinion. Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

450. Problems of Soviet Society in Transition. This seminar examines certain major problems inherent in directed social change from an agricultural to an industrial system under a totalitarian regime of the Soviet type. Attention is focused on such areas as the different phases of the revolutionary process, inconsistencies between ideological premises and the demands of industrialism, the unanticipated consequences of social change, the simultaneous impact upon the social system of industrialism and totalitarianism, and implications of the Soviet experience for other countries. 1 unit. Prerequisite: Consent of instructor. VUCINICH.

476. Urban Communities and Urbanization. Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. 1 unit. LEWIS.

477. Rural Community Organization and Development. Same as Rural Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of rural community organization; the process of community development

as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

480. **Sociological Theory and Method.** This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. 1 unit. GLASER.

482. **Recent Developments in Sociology.** Intensive study of selected topics based on contemporary works of major importance in the development of sociological theory. 1 unit. Students may reregister for a total of two units credit.

485. **The Sampling of Human Populations and Social Organizations.** Same as Psychology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples, stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

486. **Seminar on Experimental Sociology.** The logic, design, and analysis of laboratory and field experiments, with special emphasis on the controlled investigation of social processes. 1 unit. Prerequisite: Sociology 385 or equivalent, or consent of instructor.

487. **Special Problems in Rural Sociology.** Same as Rural Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

490. **Individual Topics in Sociology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. ½ to 2 units. STAFF.

494. **Multivariate Analysis in Psychology and Education.** Same as Educational Psychology and Psychology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER.

495. **Computer Applications in Social Statistical Research.** Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. DICKMAN.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Social Systems and Institutions.** An advanced discussion of general principles and concepts in sociology; among the topics discussed are culture, social structure, socialization, primary groups, social stratification; their application to problems in political sociology, industrialization, race relations, religion, and delinquency; the bearing of these upon larger problems of social order and social

change. Designed for advanced undergraduate majors in sociology and other social sciences and for graduate students in sociology without adequate preparation for graduate work. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. JOHNSON.

311. **Sociology of Intellectual Life.** A comparative sociological analysis of the development of the intelligentsia in Europe and elsewhere. Central concerns include the institutional supports for intellectual work under various social and cultural conditions, the social origin and status of different types of intellectuals, the formation of distinct scientific traditions, and the relationships of these traditions to ideology, literature, and philosophy. This involves a critical scrutiny of the theoretical literature and methodology of the sociology of knowledge. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. VUCINICH.

315. **Sociology of Education.** Same as History and Philosophy of Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, Division of General Studies or Sociology 151. SUMMERS.

316. **Sociology of Adolescence.** Adolescence in modern societies; social class, ethnic and minority group membership, and other variables as in social development, search for identity, inter-generational conflict, academic and social failure, and juvenile delinquency; the socializing institutions of family, education, peer culture, politics, religion, welfare and social control, the work world and recreation and leisure. Emphasis on research. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. CLARK.

317. **Sociology of Law.** A general treatment of the social origins and consequences of law and legal process. Special emphasis is placed on problems of legal change, on the structure and functioning of legal sanctions. Some attention is paid to law and law-like phenomena in other societies, including primitive societies, but the main focus is on American society. ½ or 1 unit. Prerequisite: Sociology 100. BORDUA.

318. **Industry and Society.** Same as Labor and Industrial Relations 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH, PHILLIPS.

320. **Social Roles.** Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. HULETT.

321. **Family, Kinship, and Crisis.** An analysis of family and kinship, with major concentration on the American family. Implications of the American kinship system for trends in courtship and mate selection, interaction among kin, and other areas of family life are investigated. Family crisis is used as a focus for analysis of family organization. ½ or 1 unit. Prerequisite: Sociology 185. FARBER.

322. **Sociology of Bureaucracy and Administrative Organization.** An analysis of major types of formal organizations from the viewpoint of generalized theories of organization and of substantive theories of bureaucratization and rationalization. Among the formal organizations studied are business enterprises and unions,

cducational and medical institutions, and non-voluntary organizations. The interrclations between bureaucracy, ideology, and social structure are particularly emphasized. ½ or 1 unit. Prerequisite: Nine hours of sociology including Sociology 300, or consent of instructor.

323. **The Small Social Group.** Same as Psychology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201. Denzin, McCall.

324. **Penology.** Probation; parole; methods of institutional treatment. ½ or 1 unit. Prerequisite: Sociology 331. Glaser.

326. **Social Mobility and Class Structure.** An advanced course in social stratification, concerned with patterns, causes, and consequences of social mobility and immobility. Includes the analysis of rising and falling classes in industrial and developing countries and the circulation of political, social, and economic elites, as well as institutional sources of individual mobility. ½ or 1 unit. Prerequisite: Sociology 223 or consent of instructor. Tien.

329. **Comparative Family Institutions.** Cross-cultural analysis of family institutions, with special reference to vital and demographic backgrounds and with stress on property, authority, and handling of deviance, and relationship to religion, economy, and polity. ½ or 1 unit. Prerequisite: Sociology 185. Farber, Lewis.

331. **Criminology.** Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal and cultural conditions. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. Clark.

332. **Research Methods in Social Psychology.** Same as Psychology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology 201 or Sociology 201; Psychology 235 or Sociology 184 and 185.

333. **Sociology of Mental Health.** Mental health issues from social organizational, demographic, and social psychological perspectives; definitions of mental illness and treatment practices relating to changing social psychological and political ideologies. The patient and the mental hospital, and the potential role of the behavioral scientist as an agent of research, treatment, and change, with special reference to current mental health action programs, are investigated. 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151, and one course in abnormal psychology and one in social psychology, or consent of instructor. DeVries.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. Gusfield.

343. **Social Change in Developing Areas.** Description and analysis of recent social and cultural changes occurring in new nations and developing economies. Special attention is given to problems of traditional social structure undergoing modernization. Social factors in economic growth, caste and class, nation-building, urbanization and population composition, education, family and religion. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151 or equivalent. Gusfield, Jacobs, Karsh.

344. **Public Opinion.** Same as Communications 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measure-

ment. ½ unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. SIMON.

350. **Soviet Social Institutions.** This course analyzes the major social institutions of Soviet society. Special attention is paid to the structural consequences of Communist ideology, totalitarianism and industrialism, and to comparison with and implications for American society. The major areas covered are: population data and their sociological implications; history, values, and ideology; political institutions; economic institutions; social stratification and mobility; the nationalities; the family and education; communications and public opinion; socialized medicine. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. The prerequisite does not apply to majors and minors in Russian language and area studies. VUCINICH.

351. **Advanced Social Psychology.** Same as Communications and Psychology 351. An integrative treatment of individual behavior variables in relation to group variables. 1 unit. Prerequisite: Sociology 201 or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. MCGRATH, STEINER.

352. **Attitude Theory and Measurement.** Same as Communications and Psychology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. 1 unit. Prerequisite: Sociology 201 or Psychology 201; a course in statistics. FISHBEIN.

355. **Chinese Society.** Systematic treatment of China's social, cultural, and demographic heritage and of the impact of the west on an ancient civilization; the processes of planned and unplanned change in Chinese society. Topics include: peasant-land economy; the family; patterns of social stratification and social mobility; the persistence of traditional forms and the adoption and adaptation of new patterns. ½ or 1 unit. Prerequisite: Sociology 100, Division of General Studies or Sociology 151 and 152, Rural Sociology 117, or consent of instructor. TIEN.

359. **The Social Psychology of Organization.** Same as Psychology 359. Analysis of the interrelationships between social and psychological factors, on the one hand, and organizational structure and process on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. DENZIN, MCGRATH.

360. **Sociology of the Professions.** This course examines the nature, position, functions, and growing importance of the major professions in the contemporary industrial (or industrializing) society. Particularly close attention is paid to the relationship between the social system and the various professional "communities," recruitment, professional socialization, and bureaucratic vs. independent practice. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. TIEN.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. TIEN, STAFF.

371. **Comparative Social Institutions.** This course examines, in a comparative perspective, some of the major institutional complexes of social systems, such as family and kinship structures, occupations, political institutions, and social stratification and mobility. Illustrative materials are drawn from a variety of societies,

including primitive nonliterate societies and advanced industrial societies such as the United States, Germany, and the Soviet Union. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor.

372. **Social Aspects of Mass Communications.** Same as Communications and Journalism 372. Media structures related to cultural content and functions; problems of life and society as treated in mass-produced communications. ½ unit.

373. **Latin-American Social Organization and Institutions.** Analysis of contemporary institutional and social class structures in Latin-American communities and societies, and their relationship to certain religious and family patterns; the influence of past and present trends in urbanization, ecological organization, and population growth upon Latin-American social systems and institutional organization. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151, or consent of instructor. SOLAUN.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Sociology, Anthropology, Geography, Health Education, Physiology, or Zoology 369. TIEN, STAFF.

385. **Social Statistics, I.** Deals intensively with descriptive statistics, probability, statistical inference, and significance testing by means of both parametric and nonparametric tests, and the various measures of association. 1 unit. Prerequisite: Sociology 185 or Mathematics 122 or 123, or consent of instructor.

386. **Methods of Field Research.** Same as Psychology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. ½ or 1 unit. Prerequisite: Sociology 184 and 185, or Psychology 235. MCCALL.

387. **Social Statistics, II.** Treats analysis of variance, analysis of covariance, multiple and partial correlations, and complicated sampling procedures. A semester problem is developed which emphasizes integration and application of various statistical techniques to sociological problems. ¾ or 1 unit. Prerequisite: Sociology 385.

SPANISH, ITALIAN, AND PORTUGUESE

The Department of Spanish, Italian, and Portuguese offers work leading to the Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are Spanish linguistics, Spanish literature, Latin-American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, or consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for any advanced degree in Spanish must possess or acquire a practical command of the language. For the Doctor of Philosophy, some knowledge of Latin and Italian or Portuguese is required. The Latin requirement

may be met by taking a minimum of one semester of Latin (two semesters in the specialization in Spanish Linguistics) while in residence for the degree. Parallel training in one or more other languages or literatures, such as English, French, German, Greek, Italian, Latin, and Portuguese, is desirable.

Master of Arts.

(1) *Spanish or Spanish-American Literature.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 309, 311, 314, 331 or 332, 351, 352; (b) Spanish 405; one of Spanish 415, 417, 419, 425; two of Spanish 421, 422, 423, 424, 426; one of Spanish 431, 432, 433, 434, 437, 438. The course program may be supplemented by courses from the doctoral list or by courses totaling one or two units in a minor or one unit in each of two minors.

(2) *Spanish Linguistics.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 309, 311, 314, 331 or 332, 351, 352, 382; general linguistics: Linguistics 300, 302; and (b) Spanish linguistics: Spanish 451 or 453; general linguistics: Linguistics 462; Spanish and Spanish-American literature: one each from two of the following groups: (i) Spanish 415, 417, 419, 425; (ii) Spanish 421, 422, 423, 424, 426; (iii) Spanish 431, 432, 433, 434, 437, 438. The course program may be supplemented by courses from the doctoral list.

(3) *The Teaching of Spanish.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305 or 306, 307 or 308, 311 or 314, and 331, 332, 351, 352; (b) one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; one of Spanish 431, 432, 433, 434, 437, 438; (c) general linguistics: Linguistics 300; (d) Educational Psychology 311, 312; (e) two of History and Philosophy of Education 301, 302, 303, 304. The course program may be supplemented by courses from the doctoral list. See pages 41 and 42.

Doctor of Philosophy.

(1) *With Specialization in the Renaissance and Golden Age.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; three of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(2) *With Specialization in the Nineteenth and Twentieth Centuries.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; one of Spanish 415, 417, 419, 425; three of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(3) *With Specialization in Latin-American Literature.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; three of Spanish 431, 432, 433, 434, 437, 438; two seminars; one of Portuguese 301, 303, 304, 407.

(4) *With Specialization in Spanish Linguistics.* The minimum requirements, in addition to those for the master's degree, are: (a) Spanish linguistics: Spanish 454 and 451 or 453; (b) Spanish and Spanish-American literature: Spanish 411, and one each from two of the following groups: (i) Spanish 425 or other (415, 417, 419); (ii) Spanish 426 or other (421, 422, 423, 424); (iii) Spanish 431 or 432 or other (433, 434, 437, 438); (c) two seminars: Spanish 452 and one in literature or language or general linguistics; (d) minor: general linguistics.

Students working toward the Doctor of Philosophy are admitted with provisional departmental status until their performance in graduate work is judged acceptable for full departmental status by the department's graduate committee.

The department should be consulted on the selection of minors. Minors available within the department are Spanish philology, and linguistics; Italian; Portuguese; Spanish and Latin-American literature. Other minors are other languages and literatures, history, philosophy, anthropology, linguistics, Latin-American studies, and other closely allied subjects.

Candidates for an advanced degree in Italian or Portuguese should consult the department. Provisions are made to fit individual cases.

GRADUATE FACULTY

Professors: W. H. Shoemaker (Head of Department), J. H. D. Allen, J. O. Crosby, J. S. Flores, H. R. Kahane, L. Leal, M. A. Morínigo, Angelina R. Pietrangeli.

Associate Professors: M. H. Forster, R. E. Lott.

Assistant Professors: S. W. Baldwin, Jr., W. C. Blaylock, W. L. Meinhardt.

Spanish

COURSES FOR GRADUATES

405. Spanish Bibliography. An introduction to bibliographical method and to the principal bibliographical resources for the study of Spanish and Latin-American literature. ½ unit. Blaylock.

411. Spanish Literature in the Middle Ages. 1 unit. Allen.

415. Renaissance and Baroque Prose in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Allen, Crosby.

417. Renaissance and Baroque Drama in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Crosby, Flores, Morínigo.

418. Seminar in Renaissance and Baroque Literature. 1 unit. Prerequisite: Spanish 415 or 417. Crosby, Morínigo.

419. Cervantes. *Don Quixote* and representative minor works. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Crosby, Morínigo.

421. Modern Spanish Novel and Essay. 1 unit. Shoemaker.

422. Contemporary Spanish Novel and Essay. 1 unit. Shoemaker.

423. Modern Spanish Drama. 1 unit. Lott, Pietrangeli, Shoemaker.

424. Contemporary Spanish Drama. 1 unit. Lott, Shoemaker.

425. Renaissance and Baroque Poetry in Spain. 1 unit. Crosby.

426. Spanish Poetry of the Nineteenth and Twentieth Centuries. 1 unit. Pietrangeli.

431. Spanish-American Poetry: Middle America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

432. Spanish-American Poetry: South America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

433. Spanish-American Novel: Middle America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal.

434. Spanish-American Novel: South America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal.

435. Seminar in Spanish-American Poetry. 1 unit. Prerequisite: Spanish 431 or 432. Forster.

436. Seminar in Spanish-American Novel. 1 unit. Prerequisite: Spanish 433 or 434. Leal.

437. Spanish-American Drama. 1 unit. Prerequisite: Spanish 307 or 308. Forster.

438. Spanish-American Essay. 1 unit. Prerequisite: Spanish 307 or 308. Leal.

443. Seminar in Galdós. Research work in novelistic criticism. Prerequisite: Spanish 305 or 306 and 311 or 314; Spanish 421 or 422. 1 unit. Shoemaker.

444. Seminar in Spanish Realism and Naturalism. Research work in nineteenth-century literary theory and practice in novel and drama. 1 unit. Prerequisite: Spanish 421 and 422. SHOEMAKER.

445. Seminar in Twentieth-Century Spanish Literature. 1 unit. Prerequisite: Spanish 421 or 422 or 423 or 424, or equivalent. LOTT, SHOEMAKER.

451. Survey of Current Research in Spanish Linguistics. Present-day methods of comparative, historical, and structural linguistics as applied to Spanish. 1 unit. KAHANE.

452. Seminar in Spanish Linguistics. Research work in Castilian and Latin-American linguistics. 1 unit. KAHANE, MORÍNIGO.

453. History of the Spanish Language. 1 unit. KAHANE, MORÍNIGO.

454. Old Spanish. 1 unit. BLAYLOCK, KAHANE, MORÍNIGO.

462. Introduction to Romance Linguistics. See Lingiustics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

471. Teaching College Spanish. A presentation of the problems of the teaching of Spanish and training in their solution, together with a study of procedures, methods, and laboratory techniques. No credit. FLORES.

491. Special Topics in Spanish. ½ or 1 unit. STAFF.

499. Thesis Research. 0 to 4 units. ALLEN, CROSBY, FORSTER, KAHANE, LEAL, LOTT, MORÍNIGO, PIETRANGELI, SHOEMAKER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Romanticism and Realism in Nineteenth-Century Spanish Literature. A study of representative authors and genres of the nineteenth century, with particular emphasis on the romantic drama and the realistic novel. ½ unit. Prerequisite: Spanish 222 or equivalent. LOTT.

306. The Generation of 1898. A study of representative works of Baroja, Azorín, Unamuno, Maeztu, Valle Inclán, Benavente, A. Machado, and others. ½ unit. Prerequisite: Spanish 222 or equivalent. LOTT.

307. Spanish-American Literature to 1888. A study of the development of Spanish-American literature from the sixteenth century through the end of the Romantic period. ½ unit. Prerequisite: Spanish 222 or equivalent. FORSTER, LEAL, MEINHARDT.

308. *Modernismo* and Contemporary Spanish-American Poetry. A study of Spanish-American poetry from 1888 to the present; some attention is given to *modernista* prose. ½ unit. Prerequisite: Spanish 222 or equivalent. FORSTER, LEAL, MEINHARDT.

309. Introduction to Medieval Spanish Literature. Historical and cultural background for the Middle Ages; selected readings in medieval literature from the *Jarchas* to the *Corbacho*. ½ unit. Prerequisite: Spanish 305, or 306, or 307, or 308, or equivalent.

311. *Don Quixote* and the Prose of the Golden Age. Introduction to *Don Quixote*, to its relationship to other selected masterpieces of the Golden Age, and to the main currents and forms of Golden Age prose. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. CROSBY, LEAL.

314. Spanish Drama and Poetry of the Golden Age. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. FLORES, HERSHBERG, MORÍNIGO.

331. La Cultura Hispánica España. Either Spanish 331 or 332 is required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. MORÍNIGO.

332. **La Cultura Hispánica: Hispanoamérica.** Either Spanish 331 or 332 is required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. LEAL, MEINHARDT, MORÍNIGO.

351. **Phonetics.** ½ unit. Prerequisite: Spanish 222 or equivalent. ALLEN, BALDWIN, FLORES, KAHANE.

352. **Syntax.** ½ unit. Prerequisite: Spanish 222 or equivalent. BALDWIN, BLAYLOCK, KAHANE, SHOEMAKER.

371. **Spanish for Teachers.** A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 222 or equivalent. FLORES.

382. **Language Laboratory Techniques.** Same as French, German, and Russian 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS.

Italian

COURSES FOR GRADUATES

411. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** 1 unit. PIETRANGELI.

412. **Italian Literature in the Middle Ages: Petrarch and Boccaccio.** 1 unit. PIETRANGELI.

415. **Italian Literature of the Renaissance.** 1 unit. PIETRANGELI.

416. **Italian Literature of the Renaissance.** 1 unit. PIETRANGELI.

451. **History of the Italian Language.** 1 unit. KAHANE.

452. **Seminar in Italian Linguistics.** 1 unit. KAHANE.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

491. **Special Topics in Italian.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for 300-level courses is Italian 101 and 102. Italian 103 and 104 are desirable.

311. **Dante: *La Divina Commedia.*** ½ unit. PIETRANGELI.

312. **Dante: *La Divina Commedia.*** Continuation of Italian 311. ½ unit. PIETRANGELI.

321. **Modern Italian Literature.** ½ unit. HERSHBERG, PIETRANGELI.

322. **Modern Italian Literature.** ½ unit. HERSHBERG, PIETRANGELI.

Portuguese

COURSES FOR GRADUATES

405. **Structure of Brazilian Portuguese: Phonology.** Phonetics and phonemics of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 104 or consent of instructor. ALLEN.

406. Structure of Brazilian Portuguese: Morphology and Syntax. Morphemics and syntax of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 405 or consent of instructor. ALLEN.

407. Studies in Brazilian Literature. Advanced study of literary movements, major writers, and intellectual and cultural ideas in Brazilian literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 301 or consent of instructor. ALLEN.

408. Studies in Portuguese Literature. Advanced study of literary movements, major writers, and intellectual and cultural ideas in Portuguese literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 302 or consent of instructor. FORSTER.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

491. Special Topics in Portuguese. ½ or 1 unit. STAFF.

499. Thesis Research. 0 to 4 units. ALLEN, FORSTER, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Brazilian Literature. Survey of the contemporary Brazilian novel. ½ unit. Prerequisite: Portuguese 103 or equivalent.

302. Introduction to Portuguese Literature. Survey of the Golden Age of Portuguese. ½ unit. Prerequisite: Portuguese 103 or equivalent.

303. Luso-Brazilian Civilization and Culture. Lectures in English, and readings in English or Portuguese, in Brazilian geography, history, politics, sociology, economics, art, and literature from the Discovery to Independence, designed to afford a broad understanding of the origins of Luso-Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Spanish 104 or Portuguese 102 or equivalent, or consent of instructor.

304. Contemporary Brazilian Civilization and Culture Since 1822. Lectures in English, and readings in English or Portuguese, in Brazilian geography, history, politics, sociology, economics, art, and literature since Independence, designed to afford a broad understanding of contemporary civilization and culture. ½ or 1 unit. Prerequisite: Spanish 104 or Portuguese 102 or equivalent, or consent of instructor.

SPEECH AND THEATRE

The Department of Speech and Theatre offers courses leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

The admission requirement, in terms of grade-point average, is at least 3.5.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theatre, oral interpretation, speech and hearing science. They may also select a special curriculum in the teaching of speech.

For the Master of Science, students may take a special curriculum in speech correction.

For the Doctor of Philosophy, students may exercise one of four options: rhetoric and public address; the theatre; speech and hearing science; experimental phonetics.

In addition to meeting general regulations of the Graduate College, the Department of Speech and Theatre specifies the requirements listed below.

Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech, including these courses or equivalents: voice

and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theatre, and an advanced course in public speaking or discussion. A thesis may be required.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated.

Master of Arts in the Teaching of Speech. Candidates for the Master of Arts who are interested in public school teaching should see pages 41 and 42 and also meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each; Speech 322 and 423, one unit each; and education, two units, including the following: History and Philosophy of Education 304 and 305, one unit, and Educational Psychology 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of theatre: speech, four units, including Speech 352, 451, 452, and one of the following: Speech 361, 362, or 366; education, two units, including the following: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; electives, two units.

Master of Science in Speech Correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all the requirements may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 475, 476, 481, 483, 484, 486, 488, 489, 491, 495; one unit from History and Philosophy of Education 304 and 305, and one unit from Educational Psychology 311 and 312; two units of electives. The electives may be in speech, in psychology, or, in exceptional cases, in other fields.

Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree in speech or theatre from an accredited institution.

GRADUATE FACULTY

Professors: K. R. Wallace (Head of Department), B. W. Hewitt, H. L. Mueller, R. Murphy, Marie H. Nichols, J. J. O'Neill, J. W. Scott, C. H. Shattuck.

Associate Professors: Mary H. Arbenz, J. J. Bateman, Clara M. Behringer, K. W. Broadrick, K. Burns, A. J. Derbyshire, O. A. Dieter, Genevieve Richardson, T. M. Scheidel, T. O. Sloan, W. L. Smalley, B. R. Works, W. R. Zemlin.

Assistant Professors: G. L. Cronkhite, Joanna L. Hawkins, R. L. Ince, F. L. Nasca, Elaine P. Paden, Lois J. Sanders, R. K. Simpson, E. W. Stark, J. W. Wenzel.

COURSES FOR GRADUATES

400. **Seminar in Dramatic Form and Structure.** Studies in the relationship of dramatic form and structure to the contemporary production of historical and modern plays. 1 unit. Prerequisite: Speech 361 and 362, or equivalent; consent of instructor. Smalley.

403. **Seminar for Teachers of Speech.** Investigation of current principles, materials, and developments in the field of speech and of their relationship to the teacher. 1 unit. Burns.

411. **The Greek Tradition in Rhetoric and Oratory.** The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to

the Renaissance; analysis of the contributions of major figures and works to that tradition. 1 unit. BATEMAN.

412. **The Roman Tradition in Rhetoric and Oratory.** Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. 1 unit. DIETER.

420. **Quantitative Methods in Rhetorical Analysis.** An introduction to the principles, procedures, and tools of research used in the quantitative analysis of the oral communication situation, including the experimental designs and statistical methods applicable to rhetorical analysis, and the identification, control, and measurement of rhetorical variables. Students participate in planning, executing, and reporting a limited experimental project investigating some oral communication variable. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Introductory course in statistics; consent of instructor. SCHEIDEL.

423. **The Rhetoric of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. 1 unit. WALLACE.

430. **Contemporary Theories of Oral Communication.** Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Consent of instructor. SCHEIDEL.

436. **Seminar in Public Discussion.** Investigation of special problems in public discussion. 1 unit. Offered in 1967-1968 and in alternate years. MURPHY.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. 1 unit. WALLACE.

441. **Historical Background of Oral Interpretation.** Historical survey of British and American theories of interpretation. 1 unit. SLOAN.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. 1 unit. Prerequisite: Speech 441; consent of instructor. SLOAN.

451. **Problems in Play Directing in the Educational Theatre.** Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. BEHRINGER.

452. **Problems in Play Production in the Educational Theatre.** Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. BEHRINGER.

461. **Advanced Theatre Techniques.** Individual development of advanced techniques of acting and staging through supervised participation in public productions. ½ or 1 unit. Prerequisite: At least one semester of graduate study in the area of theatre; consent of head of the department and of instructor.

463. **Seminar in the History of Acting.** Studies in the history and theory of the art of acting. 1 unit. Students may accumulate maximum credit of two units. Offered in 1967-1968 and in alternate years. ARBENZ.

465. **Seminar in Theatre Art.** Studies in the aesthetics of the theatre. 1 unit. HEWITT.

466. **The American Theatre Since 1900.** Major developments in acting, production, playwriting, organization, and operation. 1 unit. HEWITT.

468. **Seminar in Theatre History.** Studies in the history of the theatre. 1 unit. HEWITT.

469. **The Stage History of Classic English Plays.** Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Pre-

requisite: One year of work in dramatic literature or theatre history; consent of instructor. SHATTUCK.

472. **Psychoacoustics of Speech.** Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. 1 unit. Prerequisite: Speech 375, 376, 391 or consent of instructor. O'NEILL.

473. **Seminar in Phonetics.** Same as Linguistics 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor.

475. **Experimental Phonetics, I.** Same as Linguistics 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. **Experimental Phonetics, II.** Same as Linguistics 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. **Measurement of Speech, I.** Same as Linguistics 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. ZEMLIN.

478. **Measurement of Speech, II.** Same as Linguistics 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. ZEMLIN.

481. **Seminar in Neuropathologies of Speech and Language.** Advanced study of speech, vocal, and linguistic problems associated with cerebral palsy, aphasia, and mental retardation. 1 unit. Prerequisite: Consent of instructor.

482. **Seminar in Stuttering.** Principles, theories, and methods of clinical management of stuttering behavior in children and adults. 1 unit. Prerequisite: Speech 388.

483. **Psychology of Speech and Hearing Disorders, I.** Same as Psychology 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** Same as Psychology 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

486. **Advanced Clinical Techniques in Speech and Hearing.** Advanced clinical techniques to be used in the management of speech and hearing disorders; semi-independent management of complex cases; participation in examination and analysis. ½ to 4 units. Prerequisite: Consent of instructor.

488. **Diagnostic Procedures in Pathologies of Speech and Language.** Study of diagnostic procedures used in the analysis of neuropathologies of speech and language and orofacial and laryngeal pathologies of speech. 1 unit. Prerequisite: Consent of instructor.

489. Seminar in Orofacial and Laryngeal Pathologies of Speech. Advanced study of speech and vocal problems associated with cleft palate, laryngeal dysfunctions and facial-maxillary disturbances. 1 unit. Prerequisite: Consent of instructor.

490. Medical Aspects of Speech Disorders and Audiology. Study of acute and chronic hearing and speech disorders traceable to disease of the ear and vocal mechanisms in relation to the techniques and philosophies utilized in a medically oriented environment. 1 unit. Prerequisite: Speech 385, 388, and 486. O'Neill.

491. Seminar in Hearing Disorders. Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Speech 391.

492. Advanced Audiology. Advanced study of rationale and development of principles associated with special techniques, procedures, and methods used in audiology. 1 unit. Prerequisite: Speech 395 and 397. Stark.

495. Special Problems. Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. 1 to 2 units. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 0 to 4 units. Bateman, Behringer, Cronkhite, Dieter, Hewitt, Murphy, Nichols, O'Neill, Scheidel, Scott, Shattuck, Sloan, Smalley, Stark, Wallace, Wenzel, Zemlin.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. General Phonetics. Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit. Paden.

307. The Art of the Screen: Narration. Same as Communications 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. Mueller.

308. The Art of the Screen: Exposition and Persuasion. Same as Communications 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. Mueller.

311. British Public Address. Study of representative British speakers from the sixteenth century to the present. Lectures, reports, and papers. ½ or 1 unit. Murphy.

312. American Public Address. Study of representative American speeches from the sixteenth century to the present. ½ or 1 unit. Nichols.

313. Interpersonal Communication: Discussion and Interview. Advanced study of theory, research, techniques, and training methods in interviewing and group discussion; emphasis on empirical research findings concerning communication processes in face-to-face groups. ½ or 1 unit. Prerequisite: Consent of instructor.

321. Theories of Persuasion and Rhetorical Practice. A survey of theories of persuasion derived from rhetorical, philosophical, and psychological sources and their application to persuasive discourse. ½ or 1 unit. Prerequisite: Consent of instructor.

322. **Modern Rhetorical Theory.** Significant movements in the development of rhetorical theory in England, France, and America from 1700 to the present. ½ or 1 unit. Broadrick, Nichols.

342. **Oral Interpretation of Poetry.** Analysis and oral presentation of literature representative of various poetic forms. ½ or 1 unit. Prerequisite: Speech 141. Burns, Hawkins, Sloan.

345. **Contemporary Approaches to Oral Interpretation.** Modern concepts underlying the relationship of interpretation to the reader's experience of literature; discussions, reports, oral interpretations of prose forms (including Chamber Theatre and Readers Theatre). ½ or 1 unit. Prerequisite: Speech 141 or consent of instructor. Hawkins, Sloan.

351. **Styles of Acting for Period Plays.** Study and practice of traditional styles of acting in dramas by important playwrights representing major theatrical eras such as Sophocles, Aristophanes, Shakespeare, Racine, Moliere, Congreve, Wilde. Lectures, demonstrations, exercises, performance. ½ unit. Prerequisite: Speech 261 or consent of instructor. Arbenz.

352. **Introduction to Modern Theatre Art.** Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. Hewitt.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. Tymchyshyn.

354. **Theatre for the Child Audience.** A study of the history, objectives, and techniques of play production for the child audience, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. Tymchyshyn.

355. **Advanced Play Directing.** A study of advanced directing techniques; styles of drama; specialized procedures. ½ or 1 unit. Prerequisite: Speech 255 or equivalent. Behringer.

361. **History of the European Theatre to the Renaissance.** The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. Scott.

362. **History of the European Theatre from the Renaissance to 1900.** The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. Scott.

363. **Advanced Dramatic Writing.** Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263; consent of instructor. Smalley.

366. **Development of the American Theatre.** The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. Hewitt.

368. **History of Theatre Costume.** A survey of the history of costumes worn on the stage from the classical Greek period to the present. ½ or 1 unit. Prerequisite: Speech 361 and 362, or consent of instructor. Richardson.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. ½ or 1 unit. Prerequisite: Speech 157 and two of the following: Speech 255, 352, 361, 362; or consent of instructor. Works.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. ½ or 1 unit.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. ½ or 1 unit.

375. Speech Science, I. Same as Linguistics 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms. ½ unit. Prerequisite: Speech 109 or 301, or consent of instructor. ZEMLIN.

376. Speech Science, II. Same as Linguistics 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

377. The Bases of Speech and Hearing Science. An introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, the acoustical characteristics of speech, and the hearing of speech. Not open to students with credit in Speech 375 or 376. ½ unit. Prerequisite: Speech 109 or equivalent; consent of instructor.

383. Development of Spoken Language. A study of the correlates of language development from the prelinguistic period to adulthood. ½ or 1 unit. Prerequisite: Consent of instructor.

385. Speech Pathology, I. Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation of clinical techniques is required. ½ unit. Prerequisite: Ten hours of speech including Speech 109 and credit or registration in Speech 375, or consent of instructor. SIMPSON.

386. Basic Diagnostic and Therapeutic Principles of Speech Correction. Instruction and practice in the administration and interpretation of diagnostic tests; discussion and demonstration of clinical approaches used with speech disorders. ½ unit. Prerequisite: Speech 385; credit or registration in Speech 388.

387. Practicum in Speech Diagnosis and Therapy. Observation, practice, and research in diagnosis and therapy of speech disorders. ½ unit. Prerequisite: Speech 386; a grade-point average of at least 3.5; consent of instructor.

388. Speech Pathology, II. Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and cleft palate. ½ or 1 unit. Prerequisite: Speech 385. SIMPSON.

390. Communication Disorders in Children: Habilitation and Rehabilitation. Principles of differential diagnosis, therapeutic diagnosis, clinical and classroom habilitation and rehabilitation of children with communicative disorders etiologically associated with neurological impairment, emotional disturbance, environmental deprivation, bilingualism, and mental retardation. ½ or 1 unit. Prerequisite: Speech 383; consent of instructor.

391. Introduction to Hearing Disorders. Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. ½ unit. Prerequisite: Speech 375 or consent of instructor. STARK.

393. Aural Rehabilitation. Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling. Required in curriculum of teacher training in speech correction. ½ or 1 unit. Prerequisite: Speech 391; a grade-point average of at least 3.5; consent of instructor. NASCA.

394. Hearing Conservation. A survey of auditory screening methods, educational and protective measures, and follow-up procedures utilized in public health, public school, and college, military, and industrial settings. ½ or 1 unit. Prerequisite: Speech 391 and 395.

395. Audiometry. Principles and application of basic audiometry. ½ or 1 unit. Prerequisite: Speech 391 or consent of instructor.

396. **Diagnosis of Hearing Impairments in Infants and Young Children.** Symptoms and causes of hearing impairment in young children; practice in procedures used for the measurement of residual hearing; selection and use of hearing aids. ½ or 1 unit. Prerequisite: Speech 391 and 395, or consent of instructor.

397. **Measurement of Auditory Perception.** Principles and methods of clinical assessment of auditory perception. Intensive study of measurement techniques for speech perception; applications with clinical clients; survey of current literature and research. ½ or 1 unit. Offered in 1967-1968 and in alternate years. Prerequisite: Speech 391 and 395. O'NEILL.

398. **Practicum in Audiology.** Observation, practice, and research in diagnosis and rehabilitation of auditory disorders. ½ unit. Prerequisite: Speech 393. STARK.

399. **Design and Analysis of Experiments in Speech and Hearing Science.** An introduction to experimental designs and methods of statistical analysis in speech and hearing research. ½ or 1 unit. Prerequisite: Graduate standing or consent of instructor.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers work leading to the Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major usually have a bachelor's degree in engineering. Students having a bachelor's degree with a major in mathematics, computer science, engineering physics, engineering science, and similar areas, who have had the equivalent of the undergraduate courses usually required for the bachelor's degree in engineering, however, may also elect to major in theoretical and applied mechanics. Admission requires a 4.0 grade-point average for the last sixty semester hours of work completed in terms of a five-point scale (A = 5.0). Applications of students with grade-point averages below 4.0 but above 3.74 are considered on an individual basis.

Candidates for the Doctor of Philosophy are required to take, in addition to the thesis, at least one-half unit from each of the following areas in the department: (1) applied mathematics, (2) dynamics and vibrations, (3) fluid mechanics, (4) mechanics of solids, (5) materials engineering. A student majoring in one of these areas may elect a second minor in one of the other areas, providing the first minor is outside the department.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science is one unit; for the Doctor of Philosophy, the requirement for a sole minor is four units and for a second minor, two units.

In both Master of Science and Doctor of Philosophy programs, emphasis is placed on both course work and research, the latter being either analytical or experimental. Candidates for the master's degree, as well as for the doctorate, must submit a thesis. The department, as part of the Engineering Experiment Station, conducts many research investigations and makes studies of importance to engineering, manufacturing, and other industrial interests as well as to various governmental agencies. Some of the areas of greatest research activity are properties of materials and the elastic and inelastic behavior of load-resisting members; fracture of metals and composites, including stress corrosion cracking, fracture under sustained loading, low temperature embrittlement, stress rupture in creep, etc.; properties and behavior of plain concrete, reinforced concrete beams, columns, footings, slabs, and frames; creep of metals and of plastics and other inelastic behavior of materials; hydraulics and fluid mechanics including the nature of turbulence, boundary layer theory, etc.; stresses in railway car wheels, rails and bolted and welded rail joints; mechanical

vibrations of machines and structures and vibration damping; photoelastic, electric strain gage, and other methods of experimental stress analysis; materials subjected to static and dynamic loads; theoretical and experimental study of wave motion in continuous media; theoretical and experimental analyses of problems in fluid flow, dynamics, theory of elasticity, and theory of plasticity. Controlled environment facilities are available for investigations of plastics, plain and reinforced concrete, and wood.

Major in Applied Mathematics. Graduate students in theoretical and applied mechanics also may major in applied mathematics. The student takes at least one-half of his work in one or more of the following areas: dynamics, fluid mechanics, material engineering, or mechanics of deformable bodies. Further information concerning specific requirements for the major in applied mathematics will be sent upon request to the department.

GRADUATE FACULTY

Professors: T. J. Dolan (Head of Department), A. P. Boresi, C. E. Bowman, M. E. Clark, H. T. Corten, R. A. Eubanks, P. G. Jones, C. E. Kesler, H. L. Langhaar, W. M. Lansford, J. Morrow, J. M. Robertson, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, M. C. Stippes, C. E. Taylor, H. R. Wetenkamp, W. J. Worley.

Associate Professors: A. C. Bianchini, G. A. Costello, R. E. Miller.

Assistant Professors: F. Bauling, D. E. Carlson, R. S. Jensen, J. L. Lott, J. W. Murdock.

COURSES FOR GRADUATES

400. Seminar in Engineering Mechanics. There are many special topics in the field of mechanics such as fracture of metals, creep of materials, etc., in mechanics of solids; fluid flow problems such as the nature of turbulence, boundary layer theory, nature and effects of roughness of boundary, effects of free surface; dynamics problems such as vibration of beams with moving loads, the gyroscope, etc. Such special topics as these are covered in this course. Each semester one or more of these topics is selected and announced as the area to be covered in this course during that semester. ¼ unit. Staff.

412. Vibration Analysis. Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; nonlinear systems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311 or equivalent. Jones.

416. Energy Principles in Engineering Mechanics. Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy, Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Langhaar, Taylor.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue, and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. ½ or 1 unit. CORTEN, SINCLAIR.

425. **Mechanics of Inelastic Bodies.** The course presents methods of obtaining relations between loads, deformations, stresses, and strains in various members that are stressed beyond the elastic range. Most applications consider both time-independent and time-dependent (creep) inelastic deformations. Some specific topics are straight and curved beams, columns and beam-columns, fully plastic analysis of statically indeterminate members and structures, torsion of circular and noncircular bars, and torsion-tension of bars of circular cross-section. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321. SIDEBOTTOM, SMITH.

426. **Stress and Deformation in Engineering Components.** Continuation of Theoretical and Applied Mechanics 321: energy principles, forces and moments in plane and three-dimensional indeterminate members; beams on elastic support; flat plates, thick-walled cylinders, rotating disks, including temperature stresses; contact stresses and deflections; values and significance of stress concentrations. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321 or equivalent. SIDEBOTTOM, SMITH.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial, are emphasized. The studies involve critical reviews of experimental and analytical investigations. ½ to 1 unit. Prerequisite: Bachelor of Science in engineering. KESLER, LOTT.

428. **Analysis of Nonlinear Systems.** Same as Electrical Engineering 428. Singular points and stability considerations are treated. Graphical and analytical methods including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor. WORLEY.

431. **Theory of Ideal Fluid Flow.** Together with Theoretical and Applied Mechanics 432, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motions are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. 1 unit. Prerequisite: An elementary course in fluid flow; a course in advanced calculus. ROBERTSON, SHIRELY.

432. **Theory of Flow of Viscous Fluids.** Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially. Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and

separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. 1 unit. Prerequisite: An elementary course in fluid flow; a course in differential equations. ROBERTSON, SHIRELY.

438. **Turbulence.** Starting with the statistical modes of characterizing turbulence, discussion covers statistical theory, energy considerations, and nature of turbulence in typical flows. Laboratory experiments are used to illustrate hot wire technique of turbulence measurements and the structure of turbulence. 1 unit. Prerequisite: Theoretical and Applied Mechanics 432 or equivalent. ROBERTSON.

441. **Applied Analysis in Engineering.** A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

442. **Applied Analysis in Engineering.** Continuation of Theoretical and Applied Mechanics 441. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; Mathematics 341 or equivalent. BORESI, EUBANKS, LANGHAAR, MILLER, TAYLOR.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR, STIPPES.

454. **Theory of Shells.** A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR.

457. **Classical Elastostatics.** A modern unified treatment of the concepts and techniques developed in the course of investigation of the Cauchy-Navier equations. Emphasis on the interpretation and motivation of ideas and their interrelation for the solution of three-dimensional problems. Topics include the classical boundary-value problems, existence and uniqueness theorems, stress functions and displacement potentials, singular states of stress, extension of Green's method to the equations of elasticity, method of series, and approximation techniques. Course represents a preparation for (1) students interested in the current state of knowledge in classical elasticity, and (2) students intending to do doctoral dissertations in classical elasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent; consent of instructor. STIPPES.

458. **Wave Motion in Continuous Media.** An analysis of the dynamics of deformable bodies with a major emphasis on elastic media. Introduces the terminology associated with and the methods for treating such problems. Includes a general discussion of the motion of strings, bars, shafts, plates, and other bodies when subjected to load. Detailed examination of approximations involved is made and their engineering significance is discussed. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311, 314, 451; Mathematics 341, 342, 343, or equivalent. EUBANKS, STIPPES.

460. **Continuum Mechanics.** Foundations of the general (nonlinear) theories of continuum mechanics. A brief introduction to the tensor calculus is followed by a thorough discussion of the theory of deformation and motion of continua. The stress principle of Cauchy and the basic principles of classical mechanics, i.e., balance of momentum, moment of momentum, and energy, are discussed. A general treatment of constitutive relations is followed by detailed examination of some examples for two particular materials, the elastic solid and the stokesian fluid. 1 unit. Prerequisite: Theoretical and Applied Mechanics 351 or equivalent. CARLSON.

462. **Theory of Plasticity.** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading function. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. SIDEBOTTOM.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 416 and 451. COSTELLO. LANGHAAR,

467. **Thermomechanics of Nuclear Reactor Systems.** Same as Nuclear Engineering 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal-shock and thermal stress-wave propagation; current thermo-mechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor. BORESI.

472. **Advanced Photoelasticity.** Theoretical and practical aspects of modern photoelasticity. Topics include: three-dimensional photoelasticity, birefringent coatings, dynamic photoelasticity, photoplasticity, photoviscoelasticity, and photothermoelasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 326, 451, or consent of instructor. TAYLOR.

493. **Advanced Independent Study (Special Problems).** Analytical or experimental studies in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive study of motion having single degree of freedom; critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 154, or 156 or 211 or 212 and 221.

314. **Advanced Dynamics for Engineers.** Three-dimensional kinematics of a rigid body, general dynamics of a rigid body, moments and products of inertia, kinetic

energy, rotation of a rigid body about a fixed axis and about a fixed point, Euler equations of motion, gyroscopic theory; introduction to Lagrange equations; engineering applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 211 or equivalent; Mathematics 341 or 345.

315. **Advanced Dynamics with Applications to Engineering Problems.** General advanced methods of dynamics are discussed. Some emphasis is placed on the behavior of special components of guidance and control systems. Associated engineering problems are treated. Topics: Lagrange equations and Hamiltonian canonical equations; Hamiltonian methods; theory of vibrations; special theory of relativity, gyroscopic compass; gyroscopic stabilizer; modern gyroscopes; astronomical applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 314 or equivalent.

321. **Advanced Mechanics of Deformable Bodies.** Basic concepts of mechanics of deformable bodies and brief review of elementary topics; theory of stress and strain at a point; theories of failure, including failure by fracture; unsymmetrical bending; curved beams; torsion of noncircular sections; energy principles; Castigliano's theorem. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or 224.

324. **Flow and Fracture of Structural Metals.** Fundamental concepts of strength of crystalline engineering materials at atomic, single crystal, and polycrystalline levels of association in relation to engineering mechanisms of failure; functional relationship between material variables, state of stress, strain, time, temperature, and failure of engineering components by creep, stress rupture, fatigue, and brittle fracture. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 221 and 224, or consent of instructor.

326. **Experimental Stress Analysis.** Measurement of stresses or deformations that are of significance in the engineering design of load-resisting members; use of optical, electrical, and mechanical instrumentation, models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 212, 221, and 223 or 224. Theoretical and Applied Mechanics 321 is desirable.

334. **Fluid Mechanics and Advanced Hyrdaulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

335. **Dynamics of Fluids.** An intermediate course in the mechanics of fluids, introducing analytical methods of solution for ideal and real fluids. Potential flow theory, theoretical approaches to viscous flows including boundary-layer theory, and the analysis of compressible flows are indicated. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

346. **Dimensional Analysis and Theory of Models.** The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary-layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. ½ or 1 unit.

351. **Advanced Mechanics of Continuous Media.** General theory of stress; general theory of strain, stress-strain relationships; plane theory of elasticity; advanced topics in bending and torsion. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; a course in differential equations.

392. **Analysis and Synthesis of Problems.** This course emphasizes the rational analysis of comprehensive problems and engineering systems. ½ or 1 unit. Prerequisite: Senior standing in engineering mechanics.

URBAN PLANNING

The Department of Urban Planning offers work leading to the master's degree. Students applying for admission must have a grade-point average of at least 3.75.

Master of Urban Planning. College graduates in liberal arts and sciences as well as architecture, urban planning, civil engineering, and landscape architecture can prepare themselves for careers in city, state, and regional planning.

The graduate program typically requires two years in residence, but a student with an undergraduate degree in urban planning may complete the program in a shorter period.

To qualify for this degree, a student must take (1) the seminar and thesis courses for at least two units, (2) a total of at least six units of urban planning, and (3) at least two additional units to be chosen from the following fields: architecture, civil engineering, economics, geography, landscape architecture, political science, or sociology.

GRADUATE FACULTY

Professors: W. I. Goodman (Chairman of Department), J. M. Heikoff, L. B. Wetmore.

Associate Professors: L. F. Blair, E. C. Freund, A. Z. Guttenberg, W. B. Hansen, R. Katz, S. Keyes, J. R. Voss.

Instructor: E. P. Womack.

COURSES FOR GRADUATES

437. **Advanced Urban Planning Studio.** Analysis and synthesis problems related to design and development programming for cities, metropolitan areas, and urban regions. 1 to 2 units. Prerequisite: Urban Planning 337, 338, and 374, or consent of instructor.

487. **Seminar.** ½ unit. Prerequisite: Urban Planning 374.

488. **Urban Planning Research.** Individual and group instruction in the application of professional competences in urban planning to the analysis of urban development problems and to the formulation of approaches to solution of such problems. ½ to 2 units. Prerequisite: Urban Planning 171 or consent of instructor.

499. **Thesis Research.** ½ to 2 units. Prerequisite: Graduate standing in urban planning. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Urban Planning Studio, II.** The theory and development of the planning process as it applies to the study of an existing community, including visual surveys, data collection and analysis, "momentum projections," plan making, and implementation programs. 1 to 1½ units. Prerequisite: Urban Planning 236 or consent of instructor.

338. **Urban Planning Studio, III.** Contemporary theories of urban design and structure; planning and design of new communities; circulation and public facilities systems; studies of alternative patterns of growth. 1 to 1½ units. Prerequisite; Urban Planning 337 or consent of instructor.

351. **History of Urban Planning.** Description and analysis of the development of urbanization and the planning of communities from ancient times to the present,

as related to environmental and cultural influences. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

374. **Urban Planning Theory.** An examination of the urban planning function within a theoretical, methodological, institutional, and professional context. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

376. **Planning Analysis.** Research and analytic techniques in urban planning; economic base and employment, population, market analysis; derivation and use of statistical data. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

377. **Comprehensive Planning Procedure.** Design and plan-making techniques in urban planning; land use, circulation and community facilities; the development of the comprehensive general plan. ½ unit. Prerequisite: Urban Planning 171.

378. **Planning Legislation and Administration.** Legal tools of planning, zoning, subdivision regulations; housing codes; methodology and application; administrative procedures; the place of planning in the structure of governments; the capital improvement program. ½ unit. Prerequisite: Political Science 150, 151, or 305, 306, or consent of instructor.

380. **Survey of Regional Planning.** Concepts and procedures for planning of regions: river valley, metropolitan, state, and national planning. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine from a college or university approved by the University of Illinois. If they do not have a veterinary medical degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Areas of specialized study in veterinary medical science include anatomy, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy in Veterinary Medical Science should include in their undergraduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences.

Students planning to work toward the Doctor of Philosophy who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Departmental requirements for the Master of Science or Doctor of Philosophy in Veterinary Medical Science are described in a pamphlet which may be obtained from the office of the Dean of the College of Veterinary Medicine.

GRADUATE FACULTY

Professors: C. A. Brandly (Dean of College of Veterinary Medicine), J. O. Alberts, P. D. Beamer, L. E. Boley, H. W. Hannah, L. E. Hanson, H. J. Hardenbrook, R. D. Hatch, R. H. Kokernot, N. D. Levine, R. P. Link, M. Ristic, L. E. St. Clair, A. G. Schiller, D. Segre, P. H. Silverman, J. Simon, A. M. Watrach, G. T. Woods.

Associate Professors: D. H. Ferris, L. C. Helper, W. G. Huber, J. P. Manning, W. L. Myers, A. R. Twardock.

Assistant Professors: H. E. Rhoades, F. E. Romack, A. H. Safanie.
Instructor: Diane K. Normandin.

COURSES FOR GRADUATES

408. **Principles of Hematology.** The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. ½ unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. St. Clair.

415. **Mechanisms of Microbial Infections.** Concepts of host-microorganism relations with emphasis given to the dynamics of microorganisms and pathogenesis of specific infections. 1 unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 332, or equivalent. Hanson, Ristic.

416. **Epizootiology.** Principles and problems of epizootiology with special consideration of the zoonoses; ecology of the host and parasite as related to resistance, adaptation, perpetuation, and distribution; the principles and factors in interference, carrier and latent states, reservoirs and control. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331, Veterinary Medical Science 332, or equivalent, or consent of instructor. Brandly, Kokernot, Levine.

417. **Medical Mycology.** Study of the fungi that cause infections in man and animals; taxonomy, methodology, epidemiology, pathology, and diagnosis. 1 unit. Prerequisite: Microbiology 326, Veterinary Medical Science 332, or equivalent. Rhoades, Watrach.

418. **Concepts and Topics in Immunology.** Newer concepts and theories in the field of immunology, including theories of antibody formation, transplantation immunity, hypersensitivity, and disturbances of the antibody-forming mechanism. Lectures and discussion. ½ unit. Prerequisite: Microbiology 327 or equivalent; consent of instructor. Segre.

425. **Experimental Parasitology.** Same as Zoology 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. Fitzgerald, Levine, Silverman

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Horticulture 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Horticulture 441. A continuation of Veterinary Medical Science 440, moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Veterinary Medical Science 440 or equivalent.

445. **Advanced Macroscopic Pathology.** Concepts and interpretations of gross pathologic changes and the integration of host-parasite reactions. ½ or 1 unit. Prerequisite: Veterinary Medical Science 334 and 335, or equivalent; consent of instructor. Beamer, Simon.

450. **Advanced Veterinary Pathology.** Advanced study of gross and microscopic pathology of diseases of domestic animals. 1 unit. Prerequisite: Veterinary Medical Science 335 or equivalent. Beamer.

455. **Comparative Oncology.** A comparative study of the nature of mammalian and avian neoplasms based on general and special methods of tumor identification,

classification, and experimentation. Lectures, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 445 and 459, or equivalent. Required course for students majoring in pathology in Department of Veterinary Medical Science. SIMON.

457. **Ultrastructural Pathology.** Ultrastructural basis of pathologic processes occurring in animal tissues and cells. Lectures, discussions, and reports. ¾ or 1 unit. Prerequisite: Zoology 430; consent of instructor. WATRACH.

459. **Advanced Correlative Pathology.** Discussion and interpretation of disease processes of domestic animals. Emphasis on the correlation of gross, microscopic, and clinico-pathologic findings with alterations of function. 0 to 1½ units. Prerequisite: Veterinary Medical Science 308, 335, 445, 450, or equivalent; consent of instructor. BEAMER, SIMON, WATRACH.

460. **Advanced Veterinary Physiology.** Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Problems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. 1 unit. Prerequisite: Veterinary Medical Science 315, 316, or equivalent; consent of instructor. MCQUEEN, NEWTON.

461. **Advanced Veterinary Pharmacology.** Evaluation of drugs, pharmacological aspects of biological antagonisms, chemotherapy, antibiotics, chelating agents and chemical biological correlation. ¾ unit. Prerequisite: Consent of instructor. LINK.

463. **Radioisotopes in Biological Research: Principles and Practice.** Same as Animal Science and Biophysics 463. Lectures, demonstrations, and laboratory on the fundamentals of radioisotope procedures and applications in biology and medicine. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

490. **Seminar.** Required of all graduate students whose major is veterinary medical science. ¼ unit. STAFF.

491. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. ½ unit. LEVINE.

492. **Special Problems.** Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Gross Anatomy.** Systematic and topographic study and dissection of the dog. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. ST. CLAIR.

301. **Microscopic Anatomy.** Structure of cells, tissues, membranes, vessels, lymphoid organs, and the hollow viscera, with special reference to the domestic animal. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. NORMANDIN, ROMACK, SAFANIE.

302. **Gross Anatomy.** Comparative study and dissection of the domestic animals with special reference to development and adaptation to function. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 300 or consent of instructor. ST. CLAIR.

303. **Microscopic and Developmental Anatomy.** Structure and development of organs and systems with comparison in different domestic animals. Lectures, discus-

sions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 301 or consent of instructor. SAFANIE.

308. **Histochemistry.** Methods used in histochemical and histological analysis in animals. Lectures, discussions, demonstrations, and laboratory. ½ or 1 unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. NORMANDIN.

316. **Physiology.** Body fluids and their regulation; urine secretion; acid-base balance; physiology of renal disease in animals; metabolism; heat regulation; liver and biliary system; muscular and peripheral nervous system. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. LINK.

318. **Pharmacology.** General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures, discussions, demonstrations, and laboratory. 1 unit. Prerequisite: Credit or registration in Veterinary Medical Science 315 and 316; consent of instructor. HUBER.

320. **Pharmacology and Toxicology.** Principles of drug action and an analysis of action of chemical agents on living organisms including intoxications of domestic animals. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Veterinary Medical Science 318 or consent of instructor. HUBER.

332. **Veterinary Microbiology and Immunology.** Lectures, discussions, and laboratories dealing with mechanisms of infection and resistance and the properties, pathogenesis, and control of viral infection of domestic and wild animals. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331 or equivalent; consent of instructor. HANSON, MYERS.

333. **Protozoan and Arthropod Parasites.** Protozoan and arthropod parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. FITZGERALD.

334. **General Pathology.** The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasia. Lectures, quizzes, deomonstrations, and laboratory. 1 unit. Prerequisite: Courses in histology, parasitology, physiology, and microbiology totaling twenty-five semester hours; consent of instructor. WATRACH.

335. **Special Pathology.** Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 334 or equivalent; consent of instructor. BEAMER.

336. **Helminth Parasites.** Helminth parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. FITZGERALD.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. KENDEIGH, LEVINE, SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Sociology 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social

factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. KENDEIGH, LEVINE, STAFF.

392. **Special Problems.** Individual research on a special problem chosen in consultation with the instructor and department head. ½ unit. May be repeated for a total of one unit. Prerequisite: Registration in veterinary medical curriculum with grade-point average of 3.5 or above. STAFF.

ZOOLOGY

See descriptions and course listings under Life Sciences, page 250.

UNIVERSITY OF ILLINOIS

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